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[SECOND SERIES.]

ART. XXVIII.—*On the molecular structure of Uric Acid and its derivatives;* by WOLCOTT GIBBS, M.D., Rumford Professor in Harvard University.

IN the following memoir I shall endeavor to show that uric acid and its derivatives are members of series the limiting terms of which are on the one side polymeric forms of cyanic acid, and on the other alcohols or the corresponding hydrocarbons. I shall adopt with some slight modifications the notation of Frankland, and shall throughout consider carbon as the principal determinant.

To the molecule of free cyanic acid I give the formula

$$N\equiv C-Ho$$

in which all the bonds are saturated. By metastasis* this formula may become in combination

$$N{=}C{-}Ho, \quad \text{or} \quad \overset{|}{N}-\overset{|}{C}-Ho,$$

and in combination I give the body, NCHo, the name of cyanyl. If we replace the hydroxyl by hydrogen we have

$$N\equiv C-H$$

which in the isolated state represents a molecule of cyanhydric acid, and which by metastasis gives

$$N{=}C{-}H, \quad \text{and} \quad \overset{|}{N}-\overset{|}{C}-H.$$

* I venture to introduce this term to indicate a change or transposition of the units of combining power.

In a state of combination the body, NϵH, may be termed prussyl. With these preliminaries it is easy to see that cyanyl and its derivatives must possess a remarkable aptitude for the formation of polymeric bodies, since the first and last terms of any compound may develop at least two free units of combining power. Thus dicyanic acid when free or saturated may be

$$\begin{matrix} N{=}\epsilon{-}Ho \\ N{=}\epsilon{-}Ho \end{matrix} \quad \text{or} \quad \begin{matrix} N{-}\epsilon{-}Ho \\ N{-}\epsilon{-}Ho, \end{matrix}$$

but when combined may be

$$\begin{matrix} N{=}\epsilon{-}Ho \\ N{-}\epsilon{-}Ho, \end{matrix} \quad \begin{matrix} N{-}\epsilon{-}Ho \\ N{-}\epsilon{-}Ho, \end{matrix} \quad \begin{matrix} N{-}\epsilon{-}Ho \\ N{-}\epsilon{-}Ho, \end{matrix} \quad \begin{matrix} N{-}\epsilon{-}Ho \\ N{-}\epsilon{-}Ho. \end{matrix}$$

In like manner tricyanic or cyanuric acid has in the free state a molecular structure represented by the formula

$$\begin{matrix} N{=}\epsilon{-}Ho \\ N{-}\epsilon{-}Ho \\ N{=}\epsilon{-}Ho. \end{matrix}$$

Here again we may have by metastasis either

$$\begin{matrix} N{-}\epsilon{-}Ho \\ N{-}\epsilon{-}Ho \\ N{-}\epsilon{-}Ho \end{matrix} \quad \text{or} \quad \begin{matrix} N{=}\epsilon{-}Ho \\ N{-}\epsilon{-}Ho \\ N{-}\epsilon{-}Ho. \end{matrix}$$

From this it is easily seen that there is no limit, theoretically, to the polymeric forms of cyanyl. Of these cyamelid is doubtless one of the highest as indicated by its remarkable fixedness.

In the acids polymeric with cyanic acid cyanyl may be regarded as the acidifying term. Its quantity therefore determines the basicity of the acid, and its function is the same as that of oxatyl, $\Theta{-}\epsilon{-}Ho$, in organic acids not containing nitrogen.

Taking cyanic acid, the lowest term in the series, as the starting point, I propose for urea the formula *

$$\begin{matrix} N{=}\epsilon{-}Ho \\ H \quad N{=}H_2, \end{matrix}$$

which affords a better explanation both of the formation of urea from cyanic acid and ammonia, and of its decomposition into cyanic acid, biuret, cyanuric acid, &c., than the commonly received view which makes urea carbamid $N_2 \left\{ \begin{matrix} (\epsilon\Theta) \\ H_4. \end{matrix} \right.$ Upon this view biuret becomes

* Since the above was written I find that this formula has been proposed by Wanklyn and Gamgee. Journal of Chem. Society, vi, p. 31.

$$\begin{array}{l} N{=}C{-}Ho \\ | \quad | \\ N{-}C{-}Ho \\ | \quad | \\ H \quad N{=}H_2. \end{array}$$

Its formation from urea and relations to cyanic acid are thus clearly shown. No higher terms in this series are known, but we ought to obtain hereafter triuret, tetruret, &c., corresponding to tricyanic, tetracyanic acids, &c., just as biuret corresponds to dicyanic acid. Thus triuret would be

$$\begin{array}{l} N{=}C{-}Ho \\ | \quad | \\ N{-}C{-}Ho \\ | \quad | \\ N{-}C{-}Ho \\ | \quad | \\ H \quad N{=}H_2, \end{array}$$

and might perhaps be formed by heating together one molecule of dicyanic acid, or two of cyanic acid, and one of urea.

Guanidin and methyluramin appear also to belong to the simple cyanic acid type, their formulas being taken respectively as

$NH{=}C{=}(NH_2)_2$ and $N(CH_3){=}C{=}(NH_2)_2$

Guanidin. Methyluramin.

Dicyanic acid upon my view forms the first or completely nitrogenized term of the following series:

$$\begin{array}{lllll} N{=}C{-}Ho & O{=}C{-}Ho & O{=}C{-}Ho & H_2{=}C{-}Ho & H_2{=}C{-}H \\ | \quad | & | \quad | & | \quad | & | \quad | & | \quad | \\ N{=}C{-}Ho & O{=}C{-}Ho & H_2{=}C{-}Ho & H_2{=}C{-}Ho & H_2{=}C{-}H \end{array}$$

Dicyanic acid. Oxalic acid. Glycolic acid. Glycol. Hydrocarbon.

If we replace hydroxyl in dicyanic acid by hydrogen and its derivatives, we have the following possible compounds:

$$\begin{array}{llll} N{=}C{-}Ho & N{=}C{-}H & O{=}C{-}Ho & O{=}C{-}H \\ | \quad | & | \quad | & | \quad | & | \quad | \\ N{=}C{-}H & N{=}C{-}H & O{=}C{-}H & O{=}C{-}H \end{array}$$

Unknown. Unknown. Glyoxalic acid. Glyoxal.

To these I may be permitted to add the following which, although, with the exception of glycocoll, not derivatives of uric acid, may be regarded as cognate bodies:

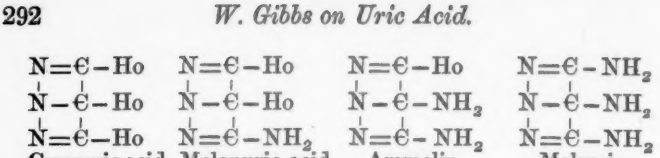
$$\begin{array}{lll} NH{=}C{-}Ho & N(CH_3){=}C{-}Ho & NH{=}C{-}(C_7H_5O) \\ | \quad | & | \quad | & | \quad | \\ H_2{=}C{-}Ho & H_2{=}C{-}Ho & H_2{=}C{-}Ho \end{array}$$

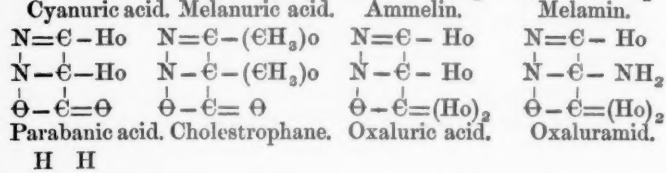
Glycocoll. Sarkosin. Hippuric acid.

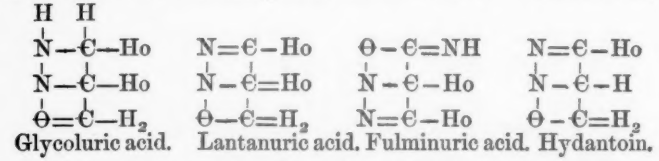
$$\begin{array}{llll} (NH){-}C{=}NH & (NH){-}C{=}NH & NH{-}C{=}NH & NH{-}C{=}NH \\ | \quad | & | \quad | & | \quad | & | \quad | \\ NH{-}C{-}Ho & N(CH_3){-}C{-}Ho & NH{-}C\diagdown\diagup O & N(CH_3){-}C\diagdown\diagup O \\ | \quad | & | \quad | & | & | \\ H_2{=}C{-}Ho & H_2{=}C{-}Ho & H_2{=}C\diagup & H_2{=}C\diagup \end{array}$$

Glycocyamin. Kreatin. Glycocyamidin. Kreatinin.

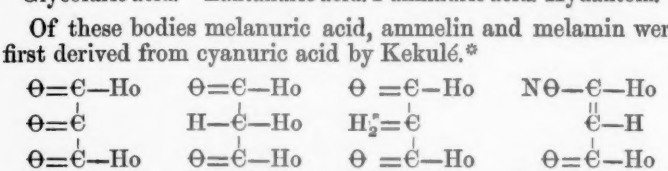
Tricyanic or cyanuric acid forms the first term of the following series:

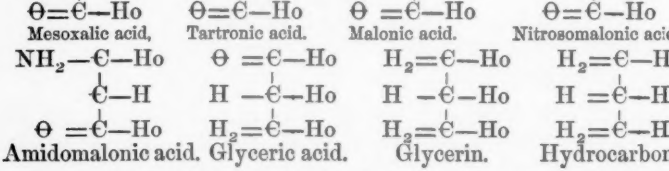




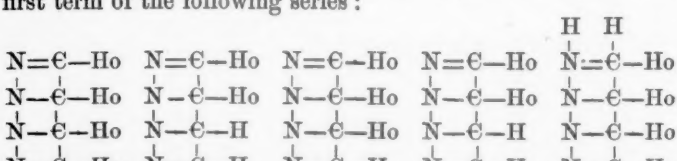


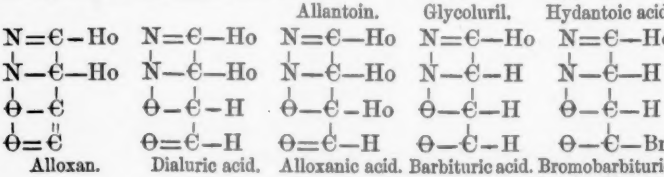
Of these bodies melanuric acid, ammelin and melamin were first derived from cyanuric acid by Kekulé.*



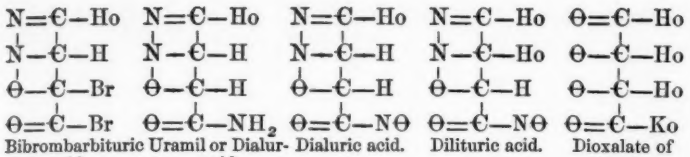


Tetracyanic acid, $C_4N_4H_4O_4$, has not yet been obtained. I consider its existence as at least probable, and take it as the first term of the following series :

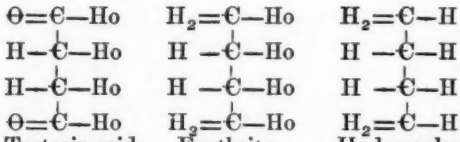




* Lehrbuch, i, p. 353.

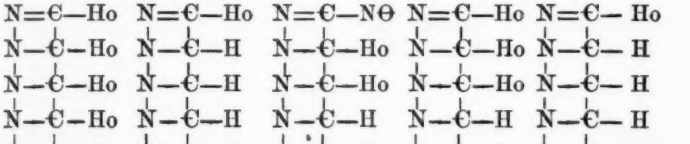


Bibrombarbituric acid. | Uramil or Dialuramid | Dialuric acid. | Dilituric acid. | Dioxalate of potassium.

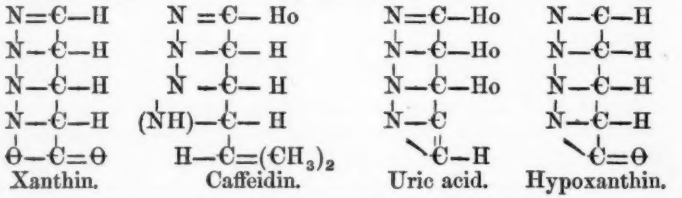


Tartaric acid. | Erythrite. | Hydrocarbon.

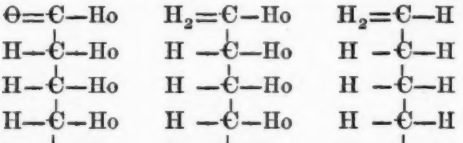
From the hypothetical pentacyanic acid we may derive the following bodies:



Pentacyanic acid. | Guanin. | Urocyanic acid.* | Uroxanic acid. | Pseudo-uric acid.



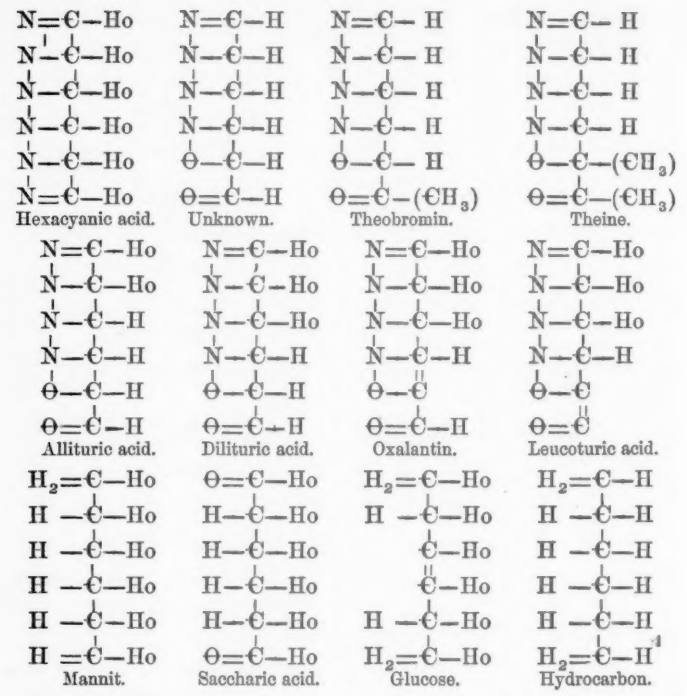
Xanthin. | Caffeidin. | Uric acid. | Hypoxanthin.



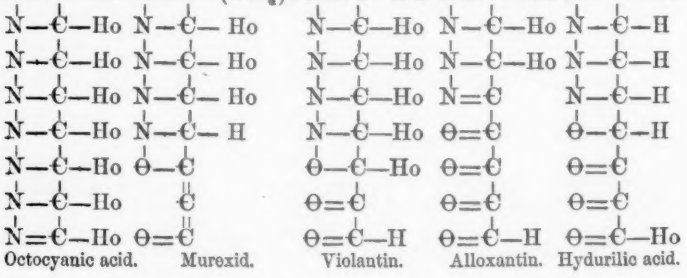
Aposorbic acid. | Unknown alcohol. | Hydrocarbon.

From hexacyanic acid we may derive the following:

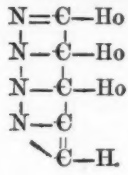
* I have given this name to a new acid obtained by the action of the alkaline nitrites upon uric acid and also, as I believe, upon cyanuric acid.



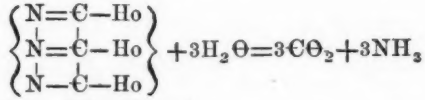
So far as I am aware no substance derived from uric acid contains 7 atoms of carbon, and it is therefore unnecessary in the present state of our knowledge to assume the existence of heptacyanic acid. The derivatives of octocyanic acid are on the contrary, though not very numerous, of much interest. They are as follows :



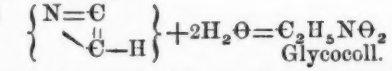
To the theory of the molecular structure of the members of the uric acid series which I have here presented, it may be justly objected that it is to a certain extent arbitrary, since it is easy to see that in many cases the elements admit of a different arrangement. I admit the force of the objection, yet it will be found, I think, upon examination, that there is less room for variation in the arrangements than might at first be supposed. Moreover, I have been guided as far as possible by the known syntheses of some substances and products of decomposition of others. Thus in the case of uric acid, Strecker has recently found that by the action of iodhydric acid it is resolved into one molecule of glycocoll, three of carbonic acid and three of ammonia, so that it may be regarded as derived from cyanuric acid and glycocoll in the same sense in which hippuric acid is derived from glycocoll and benzoic acid. The structural formula which I have given explains the decomposition effected by Strecker very simply, for we have



Now

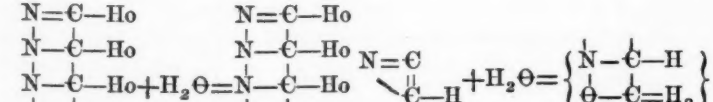


and



Glycocoll.

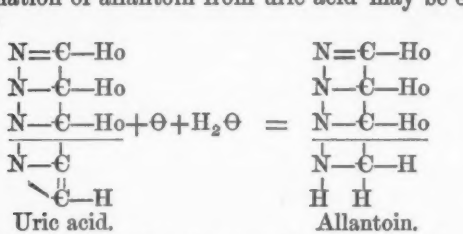
In like manner it is easily shown that uroxanic acid is derived from uric acid by the addition of one atom of water; thus



Uric acid. Uroxanic acid.

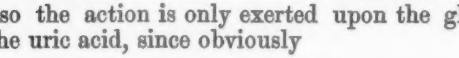
I have here taken uroxanic acid with the formula $C_5N_4H_6O_4+2H_2O$ instead of $C_5N_4H_{10}O_6$ which is usually attributed to it.

The formation of allantoin from uric acid may be explained as follows:

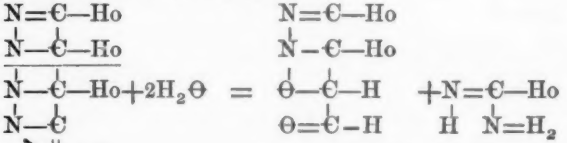


Uric acid. Allantoin.

Here also the action is only exerted upon the glycolic element of the uric acid, since obviously

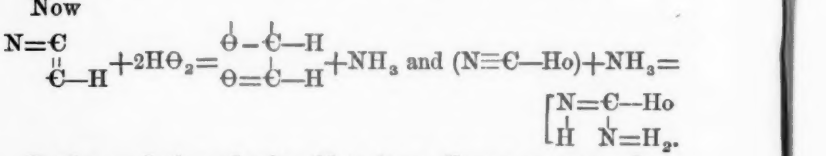


In the formation of dialuric acid from uric acid an atom of cyanyl also enters into the reaction:

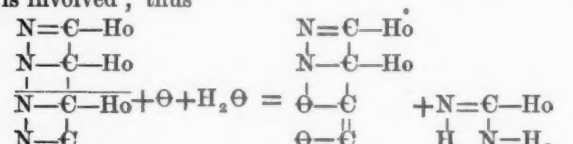


Dialuric acid. Urea.

Now

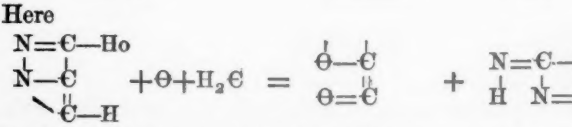


In the oxydation of uric acid to form alloxan an atom of cyanyl is involved; thus

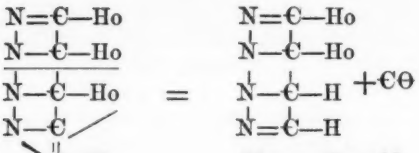


Alloxan. Urea.

Here



In the case of mycomelic acid we have



Mycomelic acid.

To explain all the transformations of the members of the uric acid series would require an inordinate extension of this paper. The reactions indicated by the following equations appear to me to find a ready explanation in the formulas which I have given above, and will serve to facilitate comparison :

$$\underset{\text{Alloxan.}}{C_4H_2N_2O_4} + H_2 = \underset{\text{Dialuric acid.}}{C_4N_2H_4O_4}$$

$$2\underset{\text{Alloxan.}}{C_4H_2N_2O_4} + H_2 = \underset{\text{Alloxantin.}}{C_8H_4N_4O_7} + H_2O$$

$$\underset{\text{Alloxan.}}{C_4H_2N_2O_4} + \underset{\text{Dialuric acid.}}{C_4N_2H_4O_4} = \underset{\text{Alloxantin.}}{C_8H_4N_4O_7} + H_2O$$

$$\underset{\text{Alloxan.}}{C_4H_2N_2O_4} + H_2O = \underset{\text{Alloxanic acid.}}{C_4H_4N_2O_5}$$

$$\underset{\text{Alloxan.}}{C_4H_2N_2O_4} + O = \underset{\text{Parabanic acid.}}{C_3H_2N_2O_3} + CO_2 .$$

One transformation deserves especial notice from its bearing upon the theory. By the action of cyanic acid upon dialuramid Baeyer obtained pseudo-uric acid, the equation expressing the reaction being

$$C_4H_5N_3O_3 + CNHO = C_5H_6N_4O_4.$$

Now in this case we have a direct passage from a lower to a higher series by simple addition of one molecule of cyanyl. It seems at least probable that further transformations of a similar kind are possible, and that the discovery of pseudo-uric acid furnishes a clue to a great number of syntheses by one or more additions of cyanyl, prussyl and cyanamid. An attentive examination of the structural formulas which I have given will show that in each series many intermediate terms remain to be discovered.

The views which I have here developed in regard to the molecular structure of the uric acid series appear to me to afford a satisfactory explanation of certain peculiarities which have long attracted the attention of chemists. The first to which I shall refer is the remarkable mobility of the constituents, and the great number of compounds which may be derived from a single primitive by the addition, subtraction or replacement of simple radicals such as hydrogen, hydroxyl, &c., and by the

metastases of the combining bonds. Cases of isomerism are not common among the nitrogenous members of the series, but the theory clearly points to their possible existence and simple explanation. That there is a very close connection between the nitrogenous and non-nitrogenous terms of the several groups can hardly I think be denied, and no theory which has hitherto been proposed offers any explanation of this connection. I am disposed to lay some stress upon this point, believing as I do that it contains the key to the explanation of chemical changes occurring within the animal economy, and gives hints which may hereafter be of service in the rational system of therapeutics to which organic chemistry in connection with physiology will ultimately lead.

The attentive study of the polymeric forms of cyanyl will also I think serve to show that a number of derivatives still remain to be formed from each primitive type, since it is clear that hydrogen and hydroxyl may not only interchange places so as to produce new compounds, but may be replaced by (NH_2) and by other residues. I may here state my conviction that every hydrocarbon is one term of a series which may be considered as derived from another term containing prussyl, cyanyl, or polymeric forms of these bodies, and one problem of organic chemistry, not yet solved or even attempted, is the systematic passage from the completely nitrogenized terms through the intervening stages to the simple hydrocarbons, or from these back to the highest nitrogen derivatives. In the simplest known case this has been done; from prussyl in the form of cyanhydric acid we pass to methylamin, from methylamin to methylic alcohol, and from this to marsh gas. Conversely we pass from marsh gas to cyanhydric acid, but in the cases of the higher terms in the series no such systematic transformation is possible in the present state of our knowledge.

In conclusion I may remark that in place of cyanyl and its multiples cyanogen and its multiples might have been assumed as primitives. I am disposed to think, however, that the method of presenting the subject which I have chosen is upon the whole better and simpler for the purpose which I had in view.

Cambridge, Aug. 15th, 1868.

ART. XXIX.—*The Occultator;* by THOMAS HILL, Cambridge, Mass.

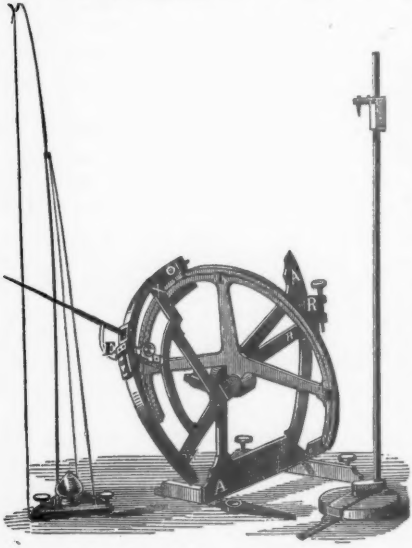
FOR several years past the appendix to the American Ephemeris and Nautical Almanac has contained a list of occultations, visible in the limits of the United States, west of the Mississippi river, calculated by aid of an instrument invented by me, in the summer of 1842. Having been requested, by one of the editors, to furnish a description of the instrument for the American Journal, I will endeavor to give it in as few words as possible.

From observations on the moon, taken from stations on the surface of the earth, astronomers have, with incredible labor, computed the moon's actual orbit, and predicted, several years in advance, her apparent path in the sky, *as it would be* seen from the center of the earth, were such observations possible; that is, as it would be seen by an observer, flying with great velocity over the earth, with such speed, and in such a path, as to keep the moon always in his zenith.

The problem in calculating an eclipse, or an occultation, is to find from this position of the moon among the stars, as seen by an observer to whom she is in the zenith, where she will appear to an observer in some other position.

The mode in which I solved this problem mechanically will, perhaps, best be understood by following the actual process of my thought in inventing the instrument. A straight wire of infinite length, passing through the centers of the earth and the moon, would mark in the sky, with one end, the moon's real geocentric place, with the other, its opposite pole. A similar wire, passing through the moon's center and the place of the observer, would mark out, with one end her apparent place, with the other its pole. These poles would have the same relative position as the places. Moreover, if the moon be taken as the center of the celestial sphere, these places and poles would keep their right position on a smaller concentric sphere. Let us then take a sphere of about sixty feet radius, or a small portion of its surface, as a chart. Vertically over it, at a distance of sixty feet we place an ideal moon, while upon the chart we will place a model of the earth with a ten-inch radius. The projection of the center on the chart being the moon's real place (or rather its pole), the projection of the observer will be the apparent place (that is, its pole); provided we use the stars instead of the moon's hour angles, &c., which relieves us of the awkward necessity of projecting from the ideal moon and allows us to project vertically.

Of course our model of the earth need be but a skeleton model, and such is "the Occultator." It consists essentially of five parts. I. The moon's meridian, AA, standing vertical upon two feet, and readily arranged by means of a projecting point on one foot and a cross scratch in mica in the other, to stand parallel to the meridians of A.R. in the chart. In the cut the projecting point in the hind foot is out of sight.



II. The equator, TT, which by means of its (axial or polar) arm, RR, and the graduated limb of A, is set to the declination of the moon (in the cut about 12°) so as to keep the ideal moon vertical over the chart).

III. The meridian of the observer, XX, which by the graduated limb of the equator is readily set to the hour angle. In the cut the hour angle is 22^h.

IV. A steel radius sliding in and out of a brass socket, E, which slides on the observer's meridian, XX, to the latitude of the place of observation, in the cut 45°.

V. Some contrivance, two specimens of which are seen by the side of the instrument, for finding the projection of the point of the rod. The one most used is the ruder one at the left, a silk thread stretched on a brass bow which is set on a triangular base, and made normal to the chart by screws in the base. The modes of using the instrument are various.

(*a*) We may draw our chart on a fixed scale of 1 inch $=6'$, and in that case, have fixed meridians drawn, and plot a new path of the moon for each occultation, and take new measures for the semi-diameter, and for the horizontal parallax, represented by the steel radius IV.

(*b*) Or we may fix the length of the steel radius at 10 inches, draw one meridian as an axis, and use Bessel's coördinates to plot the moon's path.

(*c*) But the best practical method yet tried is to plot carefully and permanently the moon's path on the chart with an

hourly motion of 5·6234 inches,—and calculate the proper values for semi-diameter and parallax, and direction of the meridian.

(*d*) Other modes have been tried, but are not worth describing.

It will be observed that the mode *a* is naturally suggested by the train of thought which led to the invention, *b* by the calculation and publication of Bessel's coördinates. The mode *c*, requiring a modification of Bessel's coördinates, was invented by my son, H. B. Hill, who has calculated the occultations for the American Ephemeris. Its advantage is, that it saves the labor of dividing the moon's hourly motion into minutes, which under the other forms is the most tedious part of the process. With the practice which he has had, he is now able to compute by this instrument the times of immersion and emersion, and the angle of emersion for sixteen different places of observation, in less than one hour. The times are supposed to be accurate to the nearest minute, unless the occultation is little more than an appulse.

The instrument was made by J. H. Temple, of Boston, who deserves great credit for his solution of a very difficult mechanical problem,—the adjustment of three motions (declination, hour angle and latitude, I might add a fourth, parallax) on axes passing through a common point, the center of the model earth.

The above description of the process of invention sufficiently demonstrates the principle of the instrument, but it may be demonstrated in quite a different way.

Let P be the elevated pole, *z* the zenith, S a star, and C the point of upper culmination, let *s* be a fictitious star, and *p* a point in the meridian below C, such that $p\,C = P\,z$. Make the angle $C\,p\,s = z\,P\,S$ and $p\,s = p\,C$. The two triangles, $z\,p\,s$, $z\,P\,S$, are evidently symmetrical, so that $s\,z = S\,z$ and the angle $s\,z\,p = z\,S\,P$. That is to say, the altitudes of *s* and S are equal, and the azimuth of *s* equals the parallactic angle of S. Hence, if over a horizontal chart a rod, equal in length to the horizontal parallax of S, be elevated to point at *s*, the projection of the rod will give both the magnitude and the direction of the parallax of S. But it is evident from the construction of the instrument that the steel rod points at *s*.

Art. XXX.—*On the Amiens Gravel;* by Alfred Tylor, Esq., F.G.S.* Plates III and IV.

I. Introduction.

The exact position, character, and equivalents of the Quaternary deposits of the valley of the Somme have been frequently discussed. On the authority of certain sections and plans of Amiens and Abbeville, the correctness of which will be examined hereafter, theoretical views concerning the relative ages of different parts of the gravel and of different parts of the valley of the Somme have been promulgated by Mr. Prestwich, and repeated by Sir C. Lyell and others.

These geologists have asserted :—

First, that there were two valley-gravels of distinct age at Amiens and Abbeville, one named by them the upper and the other the lower valley-gravel ;

Secondly, that the upper gravel was the older of the two ; and

Thirdly, that the valley of the Somme was excavated to a depth of 40 or 50 feet since the deposition of the upper valley-gravel, and previously to the deposition of the lower valley-gravel ;

Fourthly, that both gravels were fossiliferous, and contained the remains of man, or rather human implements, and bones of extinct mammalia, the lower gravels having the greater number of species of mollusca, the higher gravels containing the greater number of flint implements ;

Fifthly, that the height of 70 feet, at which fossiliferous gravels now stand above the level of the Somme, is much beyond the limit of floods, and therefore, that these gravels could only have been deposited at St.-Acheul before the river-channel was cut down to its present level.

The general effect of these assertions was to refer the remains of man found in St.-Acheul back to an indefinite date, separated from the Historical period by an interval during which valleys were excavated or deepened 40 or 50 feet.

In a paper read before this Society in April, 1866,† I suggested that there was evidence of very little weathering or atmospheric action since the date of the drift containing human remains, and that the age of these deposits was close to the Historical period,—also that the upper and lower valley-gravels in the Somme were continuous and of one period.

* From the Quarterly Journal of the Geological Society for May, 1867.

† Quart. Journ. Geol. Soc., vol. xxii, p. 463.

I afterward read, in June, 1866, a statement of what I believed to be the correct interpretation of the Amiens and Abbeville sections, reasserting the continuity of the gravel-deposits on gradual slopes from the higher to the lower levels in the valley, except in rare cases or isolated spots, where the continuity was interrupted or prevented by some upstanding piece of the original rock out of which the valley had been cut, in which case the gravel wraps round the base of the upstanding knoll of chalk. I quoted the section at Montiers as one that shows a direct sequence of gravel from above the railway to the Somme, notwithstanding the version of that locality published by Mr. Prestwich, in which chalk is represented in a position where I could only find gravel.

At the same time attention was drawn by me to the probability of the brick-earth terrace sloping down to the Lea Marshes at Clapton being of the same age as the similarly formed Loess terrace sloping down to the Somme at Amiens. I also asserted that there was good evidence in the direction and gradient of the terrace, in the configuration of the gravel and brick-earth and of the London-clay surface at Clapton, of the water having occupied the whole valley of the Lea at the time of the formation of this Clapton terrace, and also of the water of the river Lea or other rivers having reached very much higher levels in the vicinity at that period, while the Stoke-Newington and Highbury gravels and brick-earth were being deposited.

I still hold these opinions, and am prepared to demonstrate their truth; and I ask the attention of the Society to a restatement of the exact geological facts to be seen in the Somme valley, and to evidence quite independent of that which has been previously submitted to the Society, although to a certain extent going over the same ground.

The conclusions that I arrive at are extremely dissimilar to those of Mr. Prestwich and Sir C. Lyell, and are as follows :—

First, that the surface of the chalk in the valley of the Somme had assumed its present form prior to the deposition of any of the gravel or loess now to be seen there, and in this respect corresponded with all other valleys in which Quaternary deposits of this character are met with.

Second, that the whole of the Amiens-valley gravel is of one formation and of similar mineral character, and contains nearly similar organic contents, the La Neuville, Montiers, and St.-Acheul gravels being of the same age, and capped with a covering of loess also of one age and mineral character, the whole deposit being of a date not much antecedent to the Historical period.

Third, that the gravel in the valley of the Somme at Amiens is partly derived from *débris* brought down by the River Somme and by the two rivers, the Celle and the Arve, and partly consists of material from the adjoining higher grounds, washed in by land-floods,—the immense quantity of chalk present in the gravel having been derived from the latter source. It is where the surface of the chalk is concave that the gravel is thickest.

Fourth, that the Quaternary gravels of the Somme are not separated into two divisions by an escarpment of chalk parallel to the river as has been stated. They would have formed an exception to other river-gravels if this had been the case. The St.-Acheul gravels thin out gradually as they slope from the high land down to the Somme, and they pass away into the Loess formation,—and so also at Montiers.

The Loess deposit, on the contrary, forms a distinct escarpment for many miles along the Somme; and this, I believe, is the bank of the ancient river whose floods produced the St.-Acheul and Montiers gravels.

Fifth, that the existence of river-floods, extending to a height of at least eighty feet above the present level of the Somme, is perfectly proved by the gradual slope and continuity of the gravels deposited by those floods upon the sloping sides of the valley toward the Somme, and also by the Loess or warp, of similar mineral composition and color, extending continuously over the whole series of gravels, and finishing with a well-defined bank near the present stream.

Beds of gravel, brick-earth, and loess, having an even sloping surface from the escarpment of the sides of the valley down to the terrace near the river-bank, are often to be observed near other rivers whose channels bear the same proportion to their valleys that the Somme river bears to its valley, and where gravel- and loess-deposits reach to a height of 100 feet above the present river-levels.

Sixth, that many of the Quaternary deposits in all countries, clearly posterior to the formation of the valleys in which they lie, are of such great dimensions and elevation that they must have been formed under physical conditions very different from our own. They indicate a Pluvial period, just as clearly as the northern drift indicates a Glacial period. This Pluvial period must have immediately preceded the true Historical period.

Since June 1866, I have visited Amiens several times, and compared the gravels as accurately as I could, both as to situation and character, with those of other rivers, of which I have had surveys made; and I hoped to have brought the whole subject of valley-gravels before the Society in the early part of

1868. The announcement of the intended absence from England of Mr. Prestwich, has induced me to describe the Amiens gravels first, in order to have the advantage of his presence at the meeting, reserving my account of other river-gravels and general comparison to a future paper.

The plan and sections of the Quaternary deposits at Amiens illustrating this paper will, I hope, make the actual geographical and geological positions of the Amiens beds quite clear.

It should be mentioned that, in August, 1866, after examining the levels myself, I called at the railway office at Amiens to obtain the precise height of the different points on the railway above the sea, and to get the name of a competent surveyor, and was referred to the chief engineer, M. Guillom. That gentleman only saw me for a few minutes, but kindly promised that if all the points on which I required information were laid down on a plan, he would have the sections carefully taken for me in a few weeks. This plan was accordingly sent to him by me a few days afterward, with the lines marked on which I wished the levels.

The work was more tedious than was expected by M. Guillom, and he did not send me the measured sections until May, 1867. The levels of these sections have been taken with the greatest care, and, I believe, are as precise as any that have been taken for geological purposes; and I am therefore indebted to Mr. Guillom for the means of drawing an exact picture of the surface of the chalk prior, as I believe, to the deposition of any of the valley-gravel or loess at Amiens. The value of this communication therefore much depends on Mr. Guillom's survey.

The heights on the maps and sections are in English feet, the datum line being mean tide at Havre. The scale of the plan (Plate III), is $3\frac{1}{6}$ inches to a mile. The vertical scale in Plate IV, is $\frac{1}{2}$ inch to 55 feet, and is three times the horizontal scale. The dotted lines on the plan show the position of five sections, I K, R S, L M, N O P, N Q, nearly at right angles to the river, some of them extending to a height of 200 feet above the sea. The line A B is along the Imperial Road. See Plates III and IV.

II. Description of the Longitudinal Section.

There is also a longitudinal section, divided into three parts on account of the public buildings at St.-Acheul preventing continuous levels being taken. The divisions are C D, E F, and G H; but it will be treated sometimes in this paper as one section, C H. See Plate IV, fig 3, 4, and 5.

It passes through the celebrated pits of St. Acheul, and is bounded by the river Arve, a tributary of the Somme, at its eastern point, C, and by the escarpment of chalk in the Rue de Cagny (700 yards west of the railway-station, Amiens) at its western extremity, point H.

C H is near the Imperial Road, and is parallel to that road, to the railway, and to the river Somme.

Section G H.—The length of G H is 1400 feet. See Plate IV, fig. 5. The highest point is 157 feet above the sea, 79 feet above the river Arve, 3 feet over the highest part of the Imperial road, 61 feet above the rails, and 84 feet above the river Somme at Neuville. The gradient, commencing at point H, 129 feet above the sea, Rue de Cagny, rises to the east 1 in 30, then 1 in 33, 1 in 35, 1 in 61, and 1 in 100, reaching the well-known section of St.-Acheul Pit, with Roman graves, fossiliferous sand, and wavy marls, at a height of 152½ feet above the sea. A portion of this is shown in Plate IV, fig. 12.

The loess in this section is four feet at the highest, and most easterly point, G, gradually thinning to the west, and ceasing when it reaches H.

The gravel is sixteen feet thick at its most easterly point, G, thinning out as it passes to the west a little before the loess disappears.

The surface of the chalk is 133 feet above the sea at G, and 128 feet at H. The surface falls 1 in 280 to the west.

Section E F.—The surface gradient commences at F, at a height of 156 feet above the sea, and it passes the Cemetery road on the level, and rises at a gradient to the east of only 1 in 700, then falls to the east at 1 in 165 and 1 in 701, reaching the point E at a height of 154 feet above the sea (Plate IV, fig. 4).

The loess is 4 feet at F, thickening to 5 feet at the summit-level of the whole section C H, and then thinning out to 4 feet at E. The regularity of the loess is a very important fact.

The gravel is 17 feet thick at F, and 15 feet at E. The surface of the chalk is 133 feet above the sea at both E and F, showing a perfectly horizontal line, while there is only a variation in the level of the surface-loess of 3 feet in this section, which is 1586 feet long.

Section C D (Plate IV, fig 3).—Section C D commences at D with an elevation of 153¾ feet above the sea; and the gradient falls east at 1 in 157, then rises to the east 1 in 80, then falls to the east 1 in 40 and 1 in 300. Here the tramway (Plate IV, fig. 1) crosses the Imperial Road, and some very extensive gravel pits are now being worked for ballast.

The gradient continues falling east 1 in 88, 1 in 180, 1 in 160, 1 in 41, 1 in 33, and rising 1 in 200 to the east, where it reaches the escarpment at a height of 142¾ feet above the sea. The loess is here 5 feet thick, and the gravel 2 feet, according to Mr. Guillom's survey; but I found only two or three feet where I observed it. The loess is 5 feet thick near the tramway, and 4 feet at the point D. The gravel is 13 feet thick at D, and 10 feet thick at the tramway, thinning out as it approaches the escarpment on the east, as it did on the west. The surface of chalk is horizontal throughout this section also up to the escarpment.

At the escarpment, the chalk falls to the east 52½ feet in a distance of 106, or at an angle of 45° and gradient of 1 in 2 nearly. The line of slope of this escarpment is remarkably straight in many places, and quite free from gravel or loess. Then there follows a flat terrace of loess, 60 feet wide, then a slope toward the river, of 1 in 30, and then 1 in 4, until we reach the marsh at a height of 76⅓ feet above the sea.

III. Descriptions of the Transverse Sections.

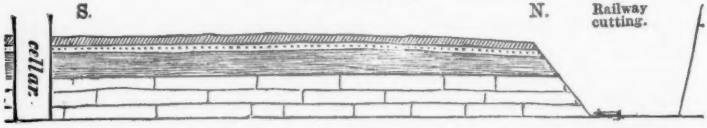
Section I K (Plate IV, fig. 6).—This section commences at the Rue de Cagny, point I, at a height of 200 feet above the sea, and falls to the river and the north at a gradient of 1 in 32, 1 in 28, 1 in 22, 1 in 18, 1 in 54. It then rises to the north at 1 in 162, and crosses the tramway ballast-pit at a level of 153¾ feet above the sea, and the Imperial Road at a height of 153 feet above the sea; it then rises to the north at a gradient of 1 in 20, reaching 156 feet above the sea, then falls toward the river at 1 in 42, 1 in 100, rises 1 in 87, falls 1 in 67, 1 in 65, 1 in 50, until in reaches the railway-cutting, at a height of 138 feet above the sea. The cutting happens to be in the escarpment of the ancient chalk valley, in which the valley-gravel has been deposited; and the surface of the gravel follows the contour of the ground, and falls at a gradient of 1 in 8, and then 1 in 7, declining 47 feet in a distance of 360 feet. The surface then falls more gently to the river at 1 in 36, 1 in 34, until it reaches the Somme.

At the point I in the Rue de Cagny the loess is 3 feet thick, and near the Imperial Road it is 8 feet thick; at one point it gradually thins out toward the river and railway, and at the railway-cutting the loess is only 2 feet thick. I do not know the thickness on the north side of the railway; but as the gravel thins out rapidly, the loess is no doubt from 10 to 12 feet thick in some points. The gravel at the point I is 5 feet thick; it increases to 10 feet thick as it approaches the Imperial Road, and after passing that at a height of 148 feet above

the sea, it gradually thins away until it is only 3 feet thick at the south side of the railway-cutting, and soon merges into the loess on the steep incline on the north side of the railway.

The surface of the chalk at the Rue de Cagny near the point I is 195 feet above the sea; it falls to 136 feet above the sea where it passes under the Imperial Road, and then becomes nearly horizontal, only falling 3 feet until it reaches the railway-cutting.

Fig. 1.—*Section at La Neuville, showing the Loess resting immediately on the Chalk.*



The slope then becomes rapid again, and it probably falls at a gradient of 1 in 4 for some distance, and then becomes horizontal again at the river Somme.

The loess is clearly seen in the railway-cutting and at one cellar (Plate III, C)* in Neuville (fig. 1), resting on chalk without any intermediate gravel, C on the plan; but I have left the junction between the loess and gravel undefined in the lower part of the section I K, as I could not put the junction in accurately.

If a straight line be drawn from point I on the Rue de Cagny to K on the Somme, it will pass 32 feet below the top of the railway-cutting along the line I K, and it will pass over the chalk at the Imperial Road at a height of 17 feet, showing that the surface of the chalk between those two points is concave.

Section L M.—(Plate IV, fig. 7.)—This section commences at the point beyond the Rue de Cagny, at a height of 187 feet above the sea; the gradient dips northward toward the river, and falls 1 in 37, until it passes the Rue de Cagny at a height of 160 feet above the sea. It passes through a part of the great St.-Acheul pit, with a gradient of 1 in 15, 1 in 40, 1 in 70, 1 in 130. Here it crosses the Imperial Road and falls to the north with a gradient of 1 in 600, 1 in 300, 1 in 40, 1 in 688, 1 in 43, to the La Neuville Railway ballast-pit close to the railway workshops, where it reaches a height of 132 feet above the sea. The ground is quarried out; but the surface apparently dipped north at a gradient of 1 in 12, then rose 1 in 33, then fell 1 in 7, horizontally crossing the railway-cutting at a height of 107 feet, 11½ feet above the rails.

* The letter C in La Neuville must be distinguished from the letter **C** in Longueau on the same Plate III.

The ground then falls north, at a gradient of 1 in 21, forming the top of the loess terrace, at 95 feet above the sea. The escarpment of the loess terrace is here at a very steep angle, falling 12 feet in a horizontal distance of 14 feet, then at a gradient of 1 in 71 to the first brook, then level to the Somme.

The loess is 4 feet thick at the Rue de Cagny, in the section L M and the same thickness at the Imperial Road. At the escarpment of the chalk it is only 2 feet thick, and seems to appear again at the terrace in considerable thickness, at a height of 95 feet above the sea.

The gravel is 13 feet thick at the Rue de Cagny, nearly 20 feet thick in the St.-Acheul pit, and runs out to 6 feet at the Railway-works ballast- and chalk-pit at the escarpment. I have no section of gravel further north than this pit.

If a straight line be drawn from the Rue de Cagny to the Somme, along the line L M, it passes the Imperial Road on the level, and is 15 feet below the surface at the Railway-works ballast-pit; so the surface is convex at that point.

The convexity of the chalk on the same line is 14 feet at the ballast pit.

Section N O P.—Plate IV, fig. 8.)—This section commences at the Ferme de Grâce, point N, at a height of 201 feet above the sea, and goes along the road to Montiers by the line N O P as far as O. The first gradient is 1 in 33, north; 1 in 90, 1 in 100, 1 in 105, 1 in 110, 1 in 110, 1 in 110, 1 in 57, 1 in 60, 1 in 70, 1 in 60. Here it crosses the junction of two roads at a height of 155 feet above the sea. Then follow on north 1 in 60, 1 in 27, 1 in 40, 1 in 60, to the point O, at a height of 120 feet above the sea; then 1 in 30 and 1 in 75 to the railway, 1 in 33 to the Imperial Road, then 1 in 56, 1 in 50, 1 in 231, and it crosses the top of the escarpment of loess at a height of 81 feet above the sea. Then the face of escarpment falls 16½ feet in 18 feet, then is horizontal to the river.

If a line be drawn from the Point N to the river Somme along the line N O P, it will pass under the junction of two roads at a height of 142 feet above the sea, or 15 feet under the roads. It will pass 10 feet above the rails, and 2 feet above the Imperial Road; so that the extreme convexity of the surface at any point of the line of 7458 feet is only 15 feet. This is important, as the section has been represented as enormously convex by previous writers.

The surface of chalk at the junction of the two roads is 142 feet above the sea, and is therefore only 6 feet above a straight line drawn through N O P. The surface of the chalk at the railway is 23 feet below a straight line drawn from the Ferme de Grâce 201 feet above the sea to the Somme (at a height of 61

feet above the sea); a straight line from the Ferme de Grâce, 201 feet above the sea to the Somme, 61 feet above the sea, passes over the railway 8 feet above the rails, and 23 feet above the surface of the chalk at that point, so that the surface of the chalk is concave to the extent of 23 feet. At the Imperial road the surface of the chalk is concave to the extent of 22 feet, although on the upper part it is convex to the extent of 15 feet.

IV. Characters of the Chalk, Gravel, and Loess.

I will not trouble the Society with the details of Section N Q (Plate IV, fig. 8), but will now proceed to describe the characters of the chalk, the gravel, and the loess, as I have observed them near Amiens.

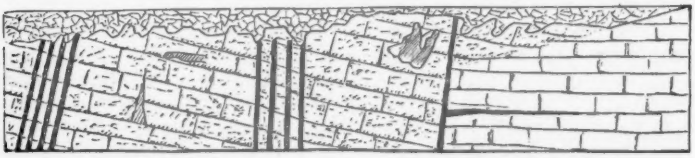
1. *The Chalk.*—The condition of the chalk itself near Amiens is remarkable in some places.

In a railway section near Pont de Metz, about three miles from Amiens and Montiers, the chalk surface slopes northward at an angle of 20°, and is overlain by 20 feet of drift sands dipping 10° N. where they touch the chalk, but filling up the concavities of the chalk, and having their upper surface sloping northward at an angle of 3°.

At Pont de Metz the chalk is covered with a drift chalk-marl, and with beds of chalk rubble and chalk pellets, with very little mixture of sand or clay, 15 to 20 feet thick.

Near Guigencourt, a quarry in the chalk on the plateau, about four miles south of Montiers, the chalk is very much split up by joints lying at an angle of eighty degrees, or very nearly vertical, and also nearly at right angles to the planes of bedding of the chalk. (Fig. 2.)

Fig. 2.—*Section exposed in a Chalk-quarry near Guigencourt.*

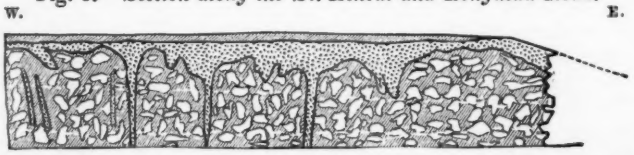


These joints are now in many cases fissures two or three inches wide, and extending to a considerable depth; but they are filled up with a fine brown loess, which seems as if injected into them; for I observed in one or two cases that a vein of two or three inches thick had entered a horizontal joint, and passed along that in a horizontal direction, thining out to only half an inch. I give a sketch of this chalk-quarry. This sys-

tem of joints would very much facilitate the formation, or rather the separation, of the chalk into rectangular and imperfect spheroids, such as are seen in the quarries behind St.-Acheul and Longueau, where some decomposing agency has acted upon the chalk itself with considerable effect.

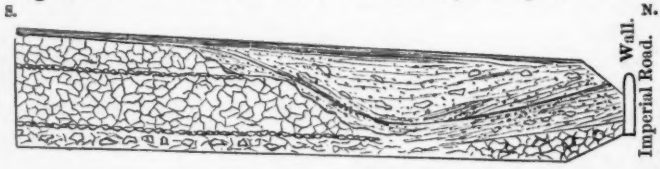
In the drawing (fig. 3) made of the condition of the surface

Fig. 3.—*Section along the St. Acheul and Longueau Road.*



of the chalk (and to a depth of 20 feet) along the Saint-Acheul and Longueau road, running east and west, I found the sand-pipes in the chalk very close together, and filled with brown loess and gravel. There are some large pipes in the eastern escarpment in M. Dailli's garden, close to the road; but they decrease toward Cagny on the escarpment of chalk trending southward there exposed, and also in the escarpment of chalk trending northward. (See fig. 4.) I did not observe any de-

Fig. 4.—*Section in M. Dailli's Garden showing decomposed Chalk.*



composed chalk in the railway-cutting or quarry between Longueau and La Neuville, nor at the ballast-pit in the chalk near La Neuville at the railway workshops, Amiens. The surface of the chalk, however, is irregular, and covered with gravel, but without deep pipes.

The drawings of the chalk-quarry, fig. 2, and in M. Dailli's garden, north of C, fig. 4, will explain the remarkable character of the decomposition that has affected the chalk. Not only has chalk been removed by the chemical action which bores pipes in it, but the loess appears to have followed closely, penetrating through the mass for many feet, occupying the vacant space made by the destruction of the calcareous matter in many places, or uniting with it, and making a kind of Combe Rock.

The harder pieces of chalk are left, often in a boulder-like form (as drawn), with slightly rounded or abraded corners, the chalk between large pieces then being loose and friable, and

marly in color, often mixed with loess, and with ferruginous stains. When the chalk is quarried, the large masses fall down like boulders, and are used for purposes of masonry, untouched by the quarryman. The hard pieces of chalk project beyond the soft matrix in which they are inclosed, like the flints upon the Brighton cliff, making a serrated face. The largest piece that has fallen out is only about three feet long, according to M. Dailli, who has quarried thousands of tons of chalk without meeting with a larger mass. There is a pipe, ten feet in diameter, in M. Dailli's garden, and the depression in the chalk at the north-east corner has a pipe-like form.

The lines of large flints which traverse the whole of the escarpment horizontally are perfectly *in situ*.

That this decomposition of the chalk *in situ* has some relation to the physical circumstances following the deposition of gravel at St.-Acheul is, I think, probable, as some part of the drainage from above St.-Acheul would pass through the escarpment in question in order to get to the marshes, and the action which has caused the removal of the chalk must have acted with great intensity on the high land adjoining, so that the current was from above downward. About one-eighth of the St.-Acheul gravel consists of chalk in the form of large pieces averaging 4 inches diameter, of chalk pellets from $\frac{1}{8}$ to $1\frac{1}{2}$ in diameter, and of chalk finely divided and mixed with clay.

Where we can see the chalk near C, it is so perforated by pipes and separated into small pieces that it seems prepared for a rapid denudation if attacked by water with any vigor; and if this was the condition of the chalk also at higher levels near St.-Acheul and Montiers, we can account for the large quantity of chalk contained in the Amiens gravels.

The fall of the Somme from Longueau to Montiers is fifteen feet, the river flowing from southeast to northwest nearly, at a gradient of only 1 in 1520. The rails are 96 feet at La Neuville, and 99 feet at Montiers, above the sea-level.

By referring to the sections, C D, E F, G H, which are parallel with the river Somme and the Imperial road, it will be seen that on a line from east to west, 1644 yards long, from the eastern escarpment of the chalk east of St.-Acheul to the western escarpment of the chalk near the northern termination of the Rue de Cagny, the surface of the chalk is extremely regular and horizontal.

The highest point of the chalk on the line C H is only three feet higher than the lowest point on that line.

There is a steep escarpment, 50 feet high, at Longueau, of bare chalk facing the east, and an escarpment 30 feet high, near

the Rue de Cagny, of bare chalk facing the west. The outcrop of chalk is marked on the plan, in order to be well seen.

The contrary is the case with the sections from south to north. The escarpment of the chalk facing the river Somme

Fig. 5.—*Section of decomposed Chalk exposed in a quarry in the escarpment near* **C**, *with bank of Loess at the base.*

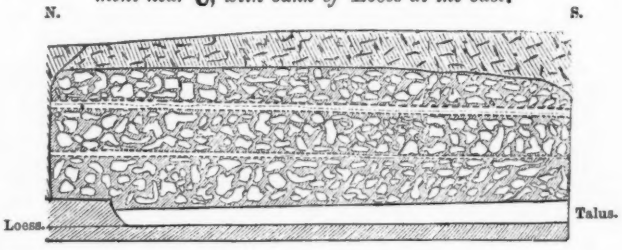
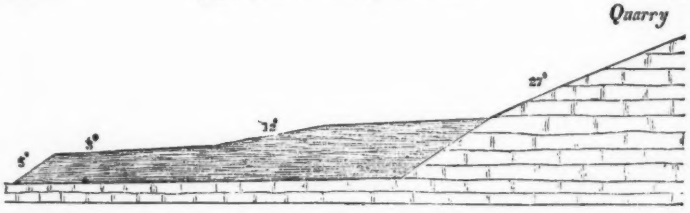


Fig. 6.—*Section showing the escarpment of Loess between the Quarry* (fig. 5) *and the Imperial Road.*



is not so steep and is therefore nowhere bare, being covered with a Quaternary deposit.

The slope of the chalk from south to north is considerable when compared with the almost perfect horizontality of the chalk in an east and west direction.

Thus we have a slope or gradient of 1 in 33, or of $2\frac{3}{4}°$, beginning at the point L on the line L M, 175 feet above the sea, to M on the Somme, at a height of 76 feet above the sea. The distance is 3342 feet between L and M. These escarpments are evidently the sides of lateral valleys, and are not due to the action of the river Somme, but to that of smaller lateral and more rapid streams running into the Somme. The river Arve still approaches closely to the eastern escarpment of St.-Acheul. The western escarpment of St.-Acheul is the side of a valley now dry, but which evidently contained a rapidly flowing stream when the western escarpment was formed.

The gradient of the river Arve is much steeper than that of the Somme ; but the valley at the west of St.-Acheul formerly contained a stream which must have fallen with great velocity,

as the slope af the bottom is 1 in 40, nearly equal to the slope of the chalk itself at St.-Acheul, which is 1 in 33. This river is now dry.

I ask particular attention to the position and level of this dry valley, which is similar in character to those occurring on all chalk-downs and plateaus.

The chalk surface at St.-Acheul is also hollowed out into a valley situated north of the Imperial Road, widening out as it approaches the Somme, after the ordinary manner of valleys.

By the sections through the St.-Acheul pits, we know this valley did not extend south of the Imperial Road; but the eastern boundary of this small valley, only 400 or 500 yards long, is well seen at the La Neuville Eastern Bridge, where the chalk is well exposed in the railway cutting, at a height of 20 feet above the rails, and slopes westward, passing under the rails near the point C in the map, between the lines of section I K and L M.

The surface of chalk is shown in a very clear section on the railway here, covered with twenty feet of loess (fig. 11). The chalk is nowhere naturally exposed. The force of water from St.-Acheul originally hollowed out this small valley in the chalk, which has been partly filled up with gravel and loess; and the surface-drainage of St.-Acheul flows to the river Somme down this valley, over a bed of gravel and loess of some thickness.

There is a very small lateral valley in the chalk, running from St.-Acheul into the now dry valley at the western escarpment, also covered with loess and gravel. The slope of the side of this valley is as much as 6°.

Crossing over from the east of Amiens to the west, we come to the section N O P, which gives us a correct view of the surface of the chalk at Montiers, where fossiliferous gravels were discovered by Mr. Prestwich. (Plate IV, fig. 7.)

The gradients have been already described. Between N and O the surface of the chalk is slightly convex; but between O, a point 120 feet above the Somme, and the Somme itself, the surface of the chalk is concave.

In an elevation of 60 feet, between O and P, the concavity of the chalk is as much as 20 feet, or one-third of the total height. It is in this basin of the chalk that the great gravel-beds of Montiers may be seen, in which 30 feet of gravel and loess is well exposed, south of and close to the Imperial Road.

The fossiliferous gravel extends above the railway; and Mr. Prestwich found shells in a pit which appears to be about 50 feet above the river at Montiers.

The chalk is nearly horizontal beneath the rails for a distance

of 1077 yards between the line of the section N O P, and N Q; at least it is 15 feet below the rails on the line N O P, and 9 feet below the rails at N Q (fig. 12, p. 123). As at St. Acheul, the slope of the surface follows the chalk to some extent, and falls toward the river. The average gradient is $2\frac{1}{4}°$, or 1 in 43, along the line N Q, against a gradient of $2\frac{3}{4}°$, or 1 in 33, at St.-Acheul, along the line L M; but the chalk is convex on the average at L M, and concave on the average at N Q. This, however, requires more explanation.

The surface of the chalk between the line of 200 feet and of 120 feet above the sea is convex on the line N O P, at the maximum to the extent of 14 feet out of 80 feet perpendicular height; and we see very little gravel reposing on the convex surface. On the contrary, in L M, between the 200-feet and 135-feet levels, the maximum concavity is 15 feet; and the great mass of the St.-Acheul gravel is deposited in this hollow.

But when we examine the surface of the chalk between O and P, between the 120-feet and 60-feet levels, we find the chalk surface is concave to the extent of a maximum of 29 feet, out of a total of 60 feet; and, singularly enough, this 29 feet is almost exactly the maximum thickness of gravel and loess in the great pit at Montiers, where a section several hundred yards long is exposed.

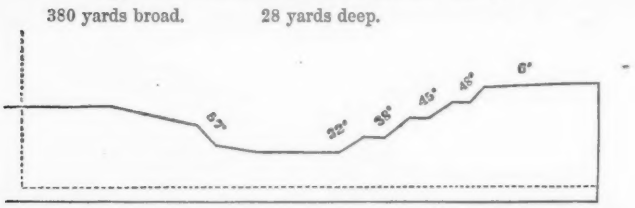
On the contrary, between the 130-feet and 76-feet levels on the lines L M and I K, where the surface of the chalk is convex, there is no gravel of any importance.

In the section (Plate IV, fig. 1), between L M and I K the chalk is nearly a straight line, falling $2\frac{1}{4}°$ between the 130-feet and 90-feet levels; we have 9 feet of gravel and loess exposed in this favorable position for its accumulation.

When we see the gradual slope of the surface from the point O to the river Somme at P, we are indeed surprised to find the sudden change in gradients in passing southward from O to Renancourt, across the now dry valley leading from Ferrières, (passing by Saveuse) to Amiens, a distance of four or five miles. These escarpments commence near Ferrières, and increase as the bottom of the valley falls in a northeasterly direction toward the river Cette. I measured a section near the Ferme de Grâce, where the side of the dry valley slopes at an angle of 20° to the bottom.

These escarpments are better shown in a section taken from the point O, toward Renancourt, and giving gradients from 30° to 50°, representing flood-lines of former periods, but so sharp in definition that they look like the work of the last winter. (Fig. 7.)

Fig. 7.—*Section across the Saveuse valley.*



It is obvious that any theory of excavation of the Somme valley, at Amiens, must take into account the condition of the dry Saveuse valley, which is only a type of hundreds of other dry valleys, which formerly were filled with water falling into the Somme and swelling it into a river capable of overflowing St.-Acheul.

In the same way no argument can be satisfactorily applied to the formation of the Somme valley, without considering the relation of the chalk-valleys generally, which resemble each other in so many important respects, and are alike in general features as well as in the mineral composition of their strata and their superficial contents.

On some other occasion, after the Society has heard my account of some other valleys, and seen my measured sections, I shall venture to lay before them the views of the formation of the Somme valley which I hold. I shall now only remark that the bottom of the valley of Saveuse opens into the valley of the Cette, between Montiers and Renancourt, at a height of 92 feet above the sea, and is 140 feet high above the sea near the Ferme de Grâce, and 187 feet above the sea near Saveuse, and that there are continuous terraces of loess, varying in form and elevation, sometimes with the configuration of the chalk-valley on which they repose from one end to the other, but evidently the consequence of water filling the Saveuse valley on its passage from Ferrières to Montiers.

2. *The Gravel and Loess.*—From the fine or coarse character of the gravel, and from the thickness of the loess, we may infer some of the physical circumstances which occurred at the period of deposition. The loess is in some places sandy, and in others is a fine loam, but it varies little in coarseness. At the same height above the river I have observed great discrepancies in the thickness of the true loess: thus, at a pit 200 yards east of the line N Q, 15 feet of loess was well exposed in a new pit from which a good quality of brick-earth was being removed and carried a long distance to the brickfields at Montiers; and I was informed there was a depth of 16 feet more before the gravel was reached. There was a gravel pit on the

same level, a little to the west. On the edge of the Saveuse valley, 400 yards south of O, the loess was only from 1 to 2 feet thick. At St.-Acheul it was only 5 or 6 feet thick; but there were intermediate beds of marl and sand between the true loess and the true gravel there.

There seems to be a line of thicker brick-earth or loess running south and north between the lines O P and N Q. This would indicate that the water was more tranquil at that point. Such differences in currents are very apparent in rivers at the present time; and the warp of our rivers approaches very nearly to the character of loess. The fossiliferous gravels at St.-Acheul extend to a height of 70 feet above the river, or much higher than the corresponding fossiliferous gravels in the valley of the Thames. The shells are found in false-bedded fine sand, and not in clay, at St.-Acheul, and in precisely the same condition as at Crayford.

The Cyrena shell-bed at Crayford, however, is only 38 feet above the sea; but both the St.-Acheul and Crayford gravels extend upward and join the plateau beds, while they pass downward as far as the river in both cases.

The chalk is capped in some places with Tertiary sands at Crayford; but the gravel lies on the concavities of chalk and sand quite indifferently.

The river Cray falls into the Thames much as the river Arve falls into the Somme. The Crayford gravel is 100 feet thick, and confined to a space between two valleys, the eastern valley occupied by the river Cray, and the other and western a dry valley, like that southwest of St.-Acheul.

Bounded by valleys east and west, the Crayford and St.-Acheul gravels lie against escarpments of the chalk parallel to the rivers Thames and Somme.

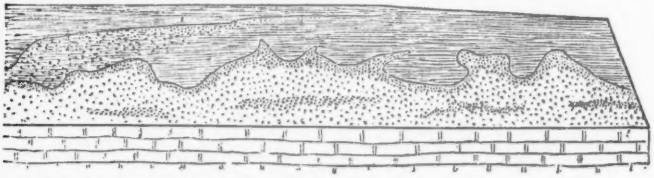
I have not presented more than a few varieties of the gravel sections to be observed in Amiens, for want of room (Plate IV, figs. 12 and 13, and fig. 8 below), and I propose to make some remarks upon the peculiarities of deposition to be observed there at some future time. I will now only observe that the character of the sections, I think, clearly shows us that a large quantity of the gravel material now exposed in the quarries opened for ballast near Amiens had its source in the hills or plateau immediately adjoining and above St.-Acheul and Montiers, and was washed into the valley of the Somme in a direction from south to north, and mingled with the materials brought down by the Somme, flowing from east to west.

The quantity of chalk-detritus is about one-eighth of the whole mass of gravel and loess, and makes the Amiens deposit second in importance to the Brighton gravel, as far as the pres-

ence of chalk is concerned. The unrolled condition in which the large pieces of chalk in the gravel generally occur proves the local origin of the chalk, and that it has been brought down from the high lands and not thrown up by the river.

We might expect an important difference in mineral character between the gravel and loess at the respective heights of 150 and 75 feet above the sea. I have compared the gravel of St.-Acheul, 140 feet above the sea, with that at Montiers, from 70 to 80 feet above the sea, as carefully as I could, in order to find some marked distinctions, but up to the present time without success. I have sketched a piece of gravel at St.-Acheul, 140 feet above the sea (Plate IV, fig. 12), and a piece in La Neuville, 105 feet above the sea, and immediately north (fig. 8).

Fig. 8.—*Section in La Neuville Ballast-pit. Loess and Gravel.*



There is a great deal of variation between these two sections; but there is still more variety in the gravel section of a part of St.-Acheul, 200 yards to the east, at a height of 145 feet above the sea (Plate IV, fig. 13). Similar species of shells have been discovered and named by Mr. Prestwich and others at Montiers and St.-Acheul, at very different levels; but there are none characteristic of any particular elevation above the river. Bones and flint implements are said to be found throughout the Amiens gravels; but as I have never found any myself, nor seen any found, I cannot speak on this point from observation; and it does not appear that these remains, any more than the shells, would enable us to distinguish any particular level.

The large stones of Grès are abundant in all the quarries. I made notes of the numbers and sizes of all I observed, and found that they are also distributed as much in the gravel above the railway as below it, and range up to 4 feet long. There are as many and as large blocks of Grès in the Montiers northern pits as in those at St.-Acheul. I observed one Grès at La Neuville partly covered by loess, the rest of the stone being on gravel; but elsewhere the Grès stones were always in the gravel.

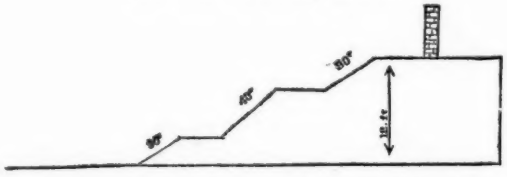
I have mentioned the loess being a very good brick-earth at a point 120 feet above the sea in Montiers. The color and material of the loess is generally a dull brown, varying in propor-

tions of clay and sand and in the amount of angular flints contained in it throughout the whole area. I have, however, remarked a reddish friable brick-earth on the terraces fringing the Somme at Longueau, ninety feet above the sea. This is probably of the same character as that in the similar terrace at Neuville and Montiers. This brick-earth is very similar to that of the river Lea; indeed at Clapton there is a well-marked terrace of brick-earth bounding the marshes, which are composed of gravel. The Clapton terrace is higher than that of the Somme at Amiens, and reposes on London clay, instead of chalk as at Amiens.

This low escarpment of loess is to be seen for a great many miles eastward along the Somme; and, from the angle at which it faces the river, with its flat top, it so resembles a military earthwork that it is often regarded as artificial. I have measured the escarpment at five or six points; and the angles vary from 20° to 40°, the average being 35° (figs. 9 and 10.)

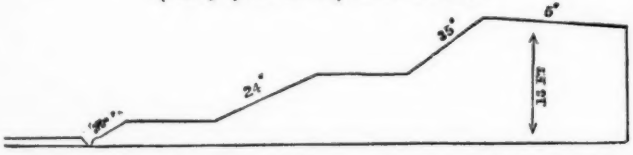
In the Saveuse valley the angles are also various. I have often remarked similar escarpments in England. I made a note

Fig. 9.—*Section near Cagny, in the valley of the Arve. Loess Terrace just above the level of Marsh.*



of a series of terraces, seven in number, one over the other, on the chalk hills, on the north side of the Somme valley, about nine miles from Amiens, on the Paris line; and, indeed, in the space of ten miles you may see twenty small lateral valleys

Fig. 10.—*Section three-quarters of a mile south of M. Daillí's house (valley of the Arve,) Loess Terrace.*



opening into the Somme, with escarpments as distinct and well marked as those drawn of the Saveuse valley.

These were steps cut in the brick-earth of the Saveuse valley by the peasants to enable them to get up the steep sides; but

that was the only information I was enabled to get as to the structure of parts of these terraces, except at Longueau, where a pit was open and good brick-earth visible; so I do not know their relation to the chalk. At Camilla Lucy House, West Humble, near Dorking, I saw a terrace cut into, sloping to the valley at 25°. The gravel was 5 feet thick on the face of chalk, and 7 feet thick 30 yards from the escarpment.

These terraces are of great importance to any one investigating the geology of the Somme, but are not noticed by any other writer as far as I am aware.

V. Conclusion.

What the sections described in this paper plainly tell us is, that the chalk valley of the Somme was excavated exactly to its present form prior to the deposition of any of the gravel now lying in it. Perhaps many layers of gravel may have been deposited and removed again in this ancient chalk valley before the present gravel was deposited; but of this we cannot be certain; so that we must take the first layer of gravel covering the chalk from the higher part of the section to the lower as the oldest in the section, and infer that the remainder of the gravel-series was deposited in regular sequence. The most delicate shells are fossilized in the river-sand of St.-Acheul and Montiers, just as they have been in that of Crayford and Erith.

This is a proof of the peaceful character of the deposition of some part of the Amiens beds, just as the large flints and blocks of Grès, which are so abundant among the gravel, are a proof of the power of the floods which brought the coarse gravel from the plateau, or down the rivers. If the sections near Amiens show the valley-gravel continuous from a height of 200 feet, at St.-Acheul and the Ferme de Grâce, to the river Somme (coated over by a nearly uniform warp of loess), and laid at a low gradient not exactly parallel to the surface of the chalk, but rather in its concavities, then we must necessarily admit that the water of the Somme has at times flowed over the whole surface in question from top to bottom in one flood. This is not an exceptional case at all, as I should have been able to demonstrate, had I been able to bring forward my sections of other river-gravels this evening. We are all agreed that a state of meteorological phenomena existed during the glacial period very different from any now to be met with in these latitudes; therefore there is no *prima facie* improbability in supposing a pluvial period even of longer range in time than the glacial epoch.

The existence of such a pluvial period is demonstrated by the size, constitution, and level of the fluviatile gravel and loess deposits at Amiens and other well-known localities. Large rivers certainly existed to a later date than the glacial period, as they formed such large terraces of loess over the glacial gravels. If we were to judge of the age of these later deposits, such as the loess escarpments at Amiens and Clapton, by their modern appearance and by their being unaltered by weather and not cut into by streams, we should place them almost in the historical period. The Amiens sections of loess accord with those of the Rhine and other rivers. The difference between this loess deposit at Amiens and the present warp of the Somme ought to be an index of the rainfall in the pluvial period, when the loess was deposited, as compared with that falling at the present time; and we may look at these gravels and loess beds as registering rain-gauges.

In the same manner, the comparative rainfall at the epoch of the deposition of gravels might be estimated approximately by comparing the dimensions of the blocks of Grès and large flints moved by fresh water in the gravel-period with the size of the materials moved in the same valleys at the present time.

The existence of a glacial period almost necessitates that of a pluvial period, commencing prior to the glacial, and continuing after it, occupying a region south of that occupied by the ice and snow.

We should have had no cause for surprise if, when the theory of a period of ice and snow in these latitudes was first broached, the probability of a rainy period south of the Thames had been also deduced from a consideration of the effects of so large a mass of ice and snow on the country and atmosphere bordering on the ice-land, but possessing a warmer climate.

We have the evidence in almost all wet valleys of the river merely occupying a small groove cut in the ancient valleys, which valleys I believe, were shaped to their present configuration in such a rainy period as I have inferred. Every wet valley has a number of dry valleys opening into it, which bear the marks of having been shaped by water and continual showers during the pluvial period.

The points of difference between other authors who have written respecting the Somme Valley and myself are as follows :—

In the appendix to Mr. Prestwich's paper in the 'Philosophical Transactions,' M. Pinsard gives the height of the railway at La Neuville as 83 feet above the mean tide at Havre. In the survey made for me by M. Guillom, Principal engineer of

the Chemin de Fer du Nord, the height is 96 feet. (Mr. Prestwich has marked this same level as 76, in his drawing, plate 10. Phil. Trans. 1860.)* This is just 13 feet below the real height. Again, in Mr. Prestwich's section, page 257, Phil. Trans. 1864, the height of the rails at Montiers is marked 130 feet; it should be 99 feet, according to M. Guillom.

It is to be regretted that Mr. Prestwich was supplied with incorrect figures of the relative levels of the ground about Amiens, as the introduction of such errors in the section must have materially affected Mr. Prestwich's theoretical views, as he says, "The upper section at Montiers, which I discovered in 1861, was conclusive as to the relative ages of the gravel" (p. 248, Phil. Trans. 1864.)

In the plan, Plate V, Phil. Trans. 1864, accompanying Mr. Prestwich's memoir, the bare chalk is shown as invariably separating the upper and lower gravels all the way from Amiens to Abbeville; but I have never seen a case of the kind.

It must be remembered that so much gravel has been removed during the last four years, that the sections are now much clearer; and, with the assistance of the accurate measurements of M. Guillom, present examiners have a great advantage over their predecessors, in examining the structure of the gravel near Amiens.

I cannot suppose that Mr. Prestwich would now separate the Montiers gravels, seen in and above the railway-cutting at Montiers, from those in the Great Montiers pit, and into two horizons, as there is only a difference of twenty-two feet between the height of the gravel on the top of the railway-cutting and that in the Imperial road. As nearly the whole space between these two points has now been excavated, the continuity of the gravel is now proved.

When Mr. Prestwich supposed that there was a continuous bare band of chalk separating the gravel in the railway-cutting at Montiers from the gravel near the Imperial road, and that the top of the railway-cutting was (according to the measurement in his section, page 257, Phil. Trans. 1864) sixty feet above the Imperial Road, he very naturally took a different view of the relations of the gravels from what we must take at the present time, with the additional information we possess.

The section on Plate IV, therefore, appears to destroy Mr. Prestwich's argument, on which he has constructed a division of the gravels at St.-Acheul and at Montiers into upper valley-gravels and lower valley-gravels, of different ages, and situated on different horizons, separated, as he supposed, by a band of bare chalk from each other,—the upper valley-gravel being

* This is calculated from the mean tide at St. Valery, which differs 7 feet from that at Havre.

supposed to have been deposited before the excavation of the last fifty feet of the Somme valley, which excavation, he considered, preceded the deposition of the gravels near the Imperial road, Montiers.

The character of the surface of the chalk at Montiers has been discussed at full length in this paper, and shown to be concave at the pits; while it is represented as highly convex at Montiers by Mr. Prestwich and Sir C. Lyell.

In the long section C D (Plate IV, fig. 3,) the St.-Acheul gravel, at a height of 140 feet above the sea, is shown to be separated from the loess at Longueau, at a height of ninety feet, by an escarpment of bare chalk. The tramway (Plate IV, fig. 1), passing from the Imperial road to the railway, crosses one of the supposed bands of chalk marked by Mr. Prestwich. But, instead of chalk, there were nine feet of good gravel and loess exposed in this cutting. The La Neuville ballast-pit, exposing ten feet of gravel and loess, is also on the supposed outcrop of bare chalk (Plate IV, fig. 2: R S on the Plan).

The outline of the sections C D and I K would at first sight seem to confirm the opinions advanced by Mr. Prestwich, that the gravel at the 140-feet level might be of a different age to that 50 feet below it.

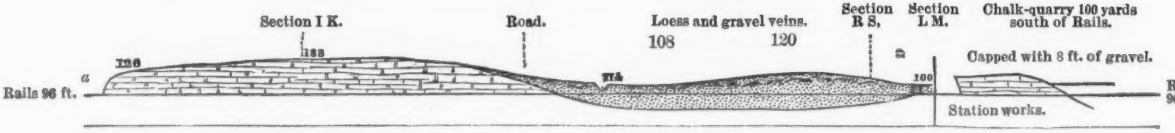
The loess, also, at Longueau, at the 90-feet level, near C, can be traced to La Neuville, and then up to the St.-Acheul pits continuously. The railway-cutting in La Neuville for half a mile is in loess, with veins of gravel (fig. 12); and this is seen to be continuous with the St.-Acheul gravel to the north, by a number of old pits, and in the tramway. The surface of the chalk is concave in this part of the La Neuville valley, between R S and I K, so that gravel and loess would be retained on it; while along the lines C D and I K there is a very steep escarpment, on which no gravel would lie. This escarpment would be swept by the stream of the river Arve and the Somme, flowing at its base, when swollen by large floods, such as must have happened in the gravel-period.

The only inference, I believe, that can be fairly drawn from the sections on Plate IV, is, that all the gravel and loess of St.-Acheul and La Neuville is of one period, and that it remained spread over the valley of the Somme where the ground was concave enough to retain it. The absence of gravel on the steep escarpments and near the river channels is a proof of great floods and rapid currents during the Quaternary period.

I saw the railway-cutting at Montiers, soon after Mr. Prestwich's visit; it was sloped and very much in the state it is at present. (Fig. 12).

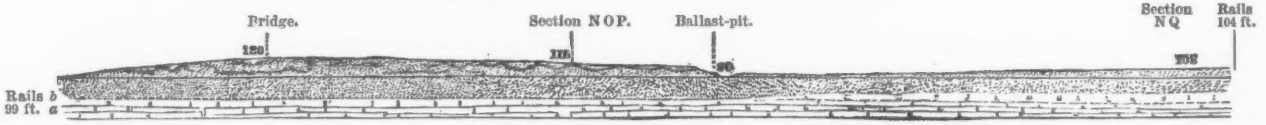
By M. Guillom's section the depth of the chalk below the rails has been accurately determined at two points, where the

Fig. 11.—*Section along the Railway from Longueau, through La Neuville to the Station works.*



Figs. 11 and 12 are only approximative, as this was not included in the part of Amiens kindly surveyed by M. Guillom.

Fig. 12.—*Section along the Railway at Montiers.*



But as the Quaternary beds below the escarpment at Longueau and La Neuville consist only of loess with thin veins of gravel and without fossils, these sections do not support the view taken by Mr. Prestwich that there is a low-level fossiliferous gravel completely separated by an escarpment of chalk from the St.-Acheul gravel.

The veins of gravel in La Neuville thicken toward the west, and the gravel in the La Neuville ballast-pit may continue beneath the Station-works; if so, this gravel is part of the stream of gravel which has descended from St.-Acheul down the La Neuville valley into the Somme, and can be traced from St.-Acheul continuously to the La Neuville ballast-pit, and passes (in thickness unknown) under the rails, as represented in the Section, fig. 11. The La Neuville deposits are not really separated from St.-Acheul by a bare band of chalk, but they wrap round the base of the high stratum of chalk which is seen in L M and I K, and which forms the east and west side of the La Neuville valley.

sections N Q and N O P cross the railway (see figs. 8 and 9, Plate IV). In fig. 8, M. Guillom found the chalk 8 feet below the rails; in fig. 9, 14 feet below the rails. Mr. Prestwich has represented this railway-cutting as on one of his bands of chalk, dividing the valley-gravels into two horizons; and in consequence, I had the section N O P taken, as nearly as I could, on the same line as Mr. Prestwich, because I had always remarked gravel in the Montiers railway-cutting, and not chalk. I also give a section along this railway (see fig. 12, page 324). By the French survey, the chalk is 14 feet below the rails. In Mr. Prestwich's section of the same place, it is 20 feet above the rails. This difference of 34 feet added to the error in the height of rails, before mentioned, of 31 feet, makes a total difference of 65 feet in the height of the chalk between Mr. Prestwich and M. Guillom, supposing I am correct in placing Mr. Prestwich's section on the line N O P.

Mr. Prestwich has recently informed me that he considers his section was intermediate between the lines N O P and N Q. As the railway-cutting ceases at the ballast-pit (fig. 12,) and there is an embankment to the west of that point for some distance, it is difficult to place Mr. Prestwich's section at any other point than where I supposed it was taken, on account of the configuration of the ground. Whether there was chalk, or not, at any one point, is quite immaterial to my argument. I do not find the Montiers section at all as represented by Mr. Prestwich and Sir C. Lyell. (See fig. 12, p. 324.)

The Montiers section appears to be the one adopted as a type of the Somme district, first by Mr. Prestwich and afterward by Sir C. Lyell. Both authors represent, in several sections of the Somme, a great extent of chalk, separating highly inclined beds of gravel, which they have distinguished in age by its position above or below this outcrop of chalk, as upper- and lower- or high- and low-level gravels. The sections which I place before the Society appear to me, on the contrary, to show that this distinction is not a real one, but that the deposit of gravel is one and continuous, deposited in concavities of an ancient chalk valley, and is not highly inclined as represented in the 'Antiquity of Man' and the 'Philosophical Transactions.'

In page 264, Phil. Trans. 1864, Mr. Prestwich gives a theoretical account of the view he takes of the deposition of the gravels. Part of the upper-level gravels are represented as remaining untouched, while the valley is cut down 50 feet, and a newer set of gravels deposited at lower levels; my sections show that there is no evidence of any such action.

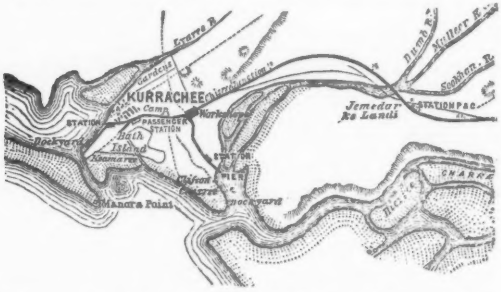
The same views are extended by Mr. Prestwich to the loess deposit; the loess of St.-Acheul is considered a much older deposit than the loess at Montiers.

Mr. Prestwich lays great stress, in his paper in the Society's Journal, p. 500, on the valley being too large to admit of the possibility of its being filled with water up to a height of 100 feet above the present water-level.

I have already submitted the argument that we ought to judge of the height of a flood by means of the *debris* it has left, and not by any theoretical notions of our own.

In 1366, twenty inches of rain fell in Scinde in twenty-four hours, in a flat country intersected by rivers. Nine girders, weighing nearly eighty tons each, were washed off the piers by the Mulleer river from the Railway bridge, situated sixteen miles above Kurrachee (fig. 13). This bridge consisted of eighteen girders (see Plate IV, fig. 10). They were not box girders, but made of wrought iron on Warren's system. The bottoms of these girders were sixty-five feet above high-water mark, spring tides, Kurrachee harbor, and seventy-four feet above low-water spring tides. They fell in the course of six hours; and one girder of the weight of eighty tons was carried two miles down the river and nearly buried in sand.* The section of the river bridge is represented (Plate IV, fig 10). The fall of the Mulleer river only averaged ten feet per mile for fifteen miles above the bridge; and as rain rarely falls, there is generally less than a foot of water in the river-bed. This bed was nearly dry

Fig. 13.—*Map of the district near Kurrachee.*



the day after, as well as the day before this excessive rainfall. Other instances of the same kind have been reported from India. The river first banked up wood and grass against the bridge and then threw the girders over. The weight of these girders moved in a river-bed of the dimensions given (Plate IV, fig. 11)† is an index of the rainfall in Scinde, just as the

* Mr. John Brunton, F.G.S., Chief Engineer of the Scinde Railway, was present at the Meeting, and confirmed this statement, which he had previously given me.

† Figs. 10 and 11, Plate IV, are from drawings supplied by Mr. W. A. Brunton, C. E.

fluviatile beds at Amiens are an index of the current of the Somme, of its flood-level, and the force of its stream. We cannot determine the rainfall at Amiens in the Quaternary Period except by its results in the form of gravel-deposits; and these appear to give as good indications as the fall of the Mulleer bridge girders does of the flood in that river.

ART. XXXI.—*On the Artificial Formation of Organic Substances;* by C. GREVILLE WILLIAMS, Esq., F.R.S.*

CHEMICAL researches are liable at various epochs to take special directions. Before 1830 organic chemistry was comparatively little studied. The simplification of the methods of organic analysis by Liebig took place at a most opportune moment, and gave an extraordinary impetus to the study of carbon compounds. So great was this influence that proximate and ultimate analysis made a progress, the rapidity of which was unexampled in the history of science.

But chemists soon became dissatisfied with merely determining the composition of substances, and they very soon began eagerly to study their products of decomposition, and in this manner get a clue to the way in which nature had put them together.

The successful attack on this problem led to a much grander one suggesting itself. This was to utilize the insight analysis had given them into the constitution of substances, and to endeavor to build them up without the assistance of life. The speaker showed that we thus arrive at the two great engines of chemical research, *analysis* and *synthesis.*

He then proceeded to define and illustrate experimentally these terms.

In organic chemistry the information supplied by the analysis of a substance often renders its synthesis easy. Water was decomposed by a battery, and its properties and quantitative relations shown. The mixed gases were then introduced into a soap-bubble, so prepared as to last a considerable time. It was by a simple contrivance attached to a thread, and the lightness of the enclosed gases was shown by the fact that the bubble was able to raise the thread and a disc of paper into the air. The energy with which the mixed gases combine to form water was then shown by applying a light to the bubble, when it burst with a loud report. The *quantitative* synthesis of water was experimentally shown by passing hydrogen over cupric oxyd in an apparatus which allowed of the collection of the water. It

* From the Proceedings of the Royal Institution of Great Britain, May 8, 1868.

was then shown that in organic chemistry the molecules are too complex to be put together so easily; and this statement was proved by reference to the constitution of methylamine, the simplest of the organic alkaloids.

The speaker then went somewhat fully into the question of the propriety of the use of the terms "organic" and "inorganic." He shewed also that all the attempts hitherto made at separating chemistry into two distinct branches had failed. Liebig's definition of organic chemistry as the "chemistry of compound radicals" being obviously inadequate, inasmuch as some compound radicals (such as sulphuryl and phosphoryl) are certainly inorganic.

Laurent's definition, "chemistry of carbon," is equally insufficient, inasmuch as carbonic anhydrid and carbonic tetrachlorid are as clearly inorganic as sulphuric anhydrid or sodic chlorid. He then proceeded to argue that chemistry was "one and indivisible," and stated that one of the chief aims of his discourse was to prove that assertion.

It was shown that until within the last few years, all the specific attempts made to break the apparently natural barriers between organic and inorganic chemistry had proved failures.

It was true that in the course of innumerable researches and experiments made by chemists, one or two of the simple organic bodies had presented themselves; but, like urea and cyanogen, they were substances which, as it were, hovered on the confines of inorganic chemistry, and would have been called inorganic had they not contained carbon.

The grand problem, which consisted in taking the elements themselves, and building them up *gradatim* into the proximate principles existing in the tissues of plants and animals, until lately appeared almost hopeless. This apparent difficulty was shown to arise from the mistake of supposing the proximate principles of animals and vegetables to result from an occult power vaguely termed the "vital force." It was at one time supposed that the laws which regulate combination were either suspended or modified in the tissues of living creatures, but the speaker urged that whenever the proper reagents were made to act upon each other under the proper conditions, the same substances were produced which at one time were supposed to require the aid of vitality for their formation.

The problem of the "synthesis," or building up of the so-called organic substances, was then shown to present itself (in the present state of chemistry) under two aspects :—1st. Where they are prepared by the aid of reagents, which have themselves been produced directly or indirectly from animals or vegetables. 2nd. Where the synthesis was effected from the free elements themselves, from hydrogen and pure carbon.

The speaker then proceeded to enumerate some of the principal instances where substances originally derived from animals or vegetables had been formed synthetically. Wöhler's synthesis of urea was shown to be one of the earliest in point of date, and his method was described, and also Kolbe's new process by the mere heating of ammonic carbonate to a point just below that at which urea is decomposed.

One of the next most important steps in the history of synthesis was shown to be the conversion of carbonic disulphid into carbonic tetrachlorid or perchlorinated marsh gas. Inasmuch as carbonic disulphid is a purely inorganic body, it is evident that any substance which can be formed from it is a case of true synthesis.

Ths following equations represent the steps by which acetic acid may be produced from carbonic disulphid :—*

$$\underbrace{CS_2}_{\text{Carbonic disulphid.}} + 6Cl_2 = \underbrace{CCl_4}_{\text{Carbonic tetrachlorid.}} + \underbrace{2(SCl_4)}_{\text{Sulphuric tetrachlorid.}}$$

$$\underbrace{2(CCl_4)}_{\text{Carbonic tetrachlorid.}} = \underbrace{C_2Cl_4}_{\text{Carbonic dichlorid.}} + 2Cl_2$$

$$\underbrace{C_2Cl_4}_{\text{Carbonic dichlorid.}} + Cl_2 = \underbrace{C_2Cl_6}_{\text{Carbonic trichlorid.}}$$

$$\underbrace{C_2Cl_6}_{\text{Carbonic trichlorid.}} + 2(H_2O) = \underbrace{C_2HCl_3O_2}_{\text{Trichloracetic acid.}} + 3(HCl)$$

$$\underbrace{C_2HCl_3O_2}_{\text{Trichloracetic acid.}} + 3H_2 = \underbrace{C_2H_4O_2}_{\text{Acetic acid.}} + 3HCl$$

This important series of reactions, then, result in the production of acetic acid, one of the most marked of the so-called organic acids, from purely inorganic materials.

The synthesis of oxalic acid by the direct union of carbonic anhydrid with sodium, as recently accomplished by Dr. Drechsel, was next described, and it was shown that as oxalic acid, by mere distillation, yields formic acid, the synthesis of the first acid leads directly to a new synthesis of the second.

The other modes of effecting the synthesis of formic acid were then pointed out, viz :—Berthelot's process, which consist in heating potassic hydrate in an atmosphere of carbonic oxyd; and Kolbe and Schmidt's methods, by exposing potassium to a warm moist atmosphere of carbonic anhydrid.

The speaker, in the course of his remarks on the constitution of formic acid, showed that the quantity of oxygen in it was so large that it only required one atom more to convert it into carbonic acid and water. Its easy oxydation was illustrated by

[* C=12, O=16, S=32, etc]

letting it fall on plumbic dioxyd in an apparatus which caused the evolved gas to pass into a solution of baric hydrate, the result being a copious precipitation of baric carbonate.

Having shown that acetic acid can be formed from carbonic disulphid and the chlorids of carbon, and oxalic and formic acids from the oxyds of carbon, the speaker proceeded to indicate the modes in which complex bodies, hitherto obtained from animal and vegetable sources, can be built up from elemental carbon and hydrogen.

If carbon can only be made to combine directly with hydrogen, no matter how simple the resulting compound may be, it becomes possible to effect the synthesis of a vast number of the most characteristic substances found in animals and vegetables.

This brilliant result has been accomplished through the agency of acetylene, a most remarkable hydrocarbon which was first noticed by Edmund Davy as long ago as 1836.

There are two methods by which acetylene can be formed from inorganic materials—one devised by Berthelot, and the other by the speaker. The first consists in passing a stream of hydrogen through a globe in which the voltaic arc (from 70 or 80 cells of a Grove's battery) is produced between carbon points. At this tremendous temperature the carbon unites directly with the hydrogen. The experiment was made, and the production of acetylene shown, by the formation of a precipitate in a solution of ammoniacal cuprous chlorid.

The speaker then showed, experimentally, that much larger quantities of acetylene can be formed by the decomposition by the induction spark of carbonic tetrachlorid in presence of hydrogen, in accordance with the equation:—

$$2(CCl_4) + 5H_2 = C_2H_2 + 8(HCl).$$

The experiment succeeded perfectly, and a large quantity of the cuprous acetylid was rapidly produced.

But the most simple and ready means of preparing acetylene was shown to be by drawing air through the flame of a common glass spirit-lamp, by means of an aspirator. So readily is the cuprous precipitate obtained by this means, that it suffices to draw a few cubic centimeters through the solution of ammoniacal cuprous chlorid to obtain evidence of the presence of acetylene in the flame. The experiment was then made, and in a few seconds the solution became thick with the suspended precipitate.

The speaker had ascertained that all the homologues of olefiant gas give acetylene in abundance when subjected to the induction spark. Amylene does it readily in accordance with the annexed equation:—

$$\underbrace{2(C_5H_{10})}_{\text{Amylene.}} = \underbrace{5(C_2H_2)}_{\text{Acetylene.}} + 5H_2.$$

That the spark acted only in consequence of its high temperature, the speaker said, is rendered probable by the fact that if hydrogen be passed through carbonic tetrachlorid, and then into a globe containing a platinum spiral, when the latter was heated to dull redness by three cells of a Grove's battery, no acetylene was produced; but when five cells were used, and the spiral became white hot, the cuprous precipitate was obtained readily. The same result was stated to occur with amylene.

Simple as the formula of acetylene is, almost all the animal and vegetable substances which have been formed hy pure synthesis may be obtained from it.

The following equations represent the steps by which alcohol may be "synthesised." It is proper to premise that the conversion of acetylene into olefiant gas is accomplished by treating the cuprous acetylid with zinc and ammonia, so as to obtain nascent hydrogen :—

$$\underbrace{C_2H_2}_{\text{Acetylene.}} + H_2 = \underbrace{C_2H_4}_{\text{Ethylene.}}$$

$$\underbrace{C_2H_4}_{\text{Ethylene.}} + H_2SO_4 = \underbrace{H, C_2H_5SO_4}_{\text{Ethyl-sulphuric acid.}}$$

$$\underbrace{H, C_2H_5SO_4}_{\text{Ethyl-sulphuric acid.}} + H_2O = \underbrace{C_2H_6O}_{\text{Alcohol.}} + H_2SO_4$$

The synthesis of succinic acid from acetylene was next shown in accordance with the annexed equations, omitting the synthesis of ethylene, which has been already given:—

$$\underbrace{C_2H_4}_{\text{Ethylene.}} + Br_2 = \underbrace{C_2H_4Br_2}_{\text{Ethylenic dibromid.}}$$

$$\underbrace{C_2H_4Br_2}_{\text{Ethylenic dibromid.}} + \underbrace{2(KCN)}_{\text{Potassic cyanid.}} = \underbrace{C_2H_4(CN)_2}_{\text{Ethylenic dicyanid.}} + 2(KBr)$$

$$\underbrace{C_2H_4(CN)_2}_{\text{Ethylenic dicyanid.}} + 2(KHO) + 2(H_2O) = \underbrace{C_4H_4K_2O_4}_{\text{Potassic succinate.}} + 2(NH)_3$$

This mode of effecting the synthesis of succinic acid is due to the researches of Maxwell Simpson.

The beautiful appearance of succinic acid under the influence of polarized light was shown by the aid of the electric lamp. The specimen used had been artificially prepared.

The speaker then proceeded to show that the synthesis of succinic acid was a direct step to that of tartaric acid. This latter reaction is due to the researches of Perkin and Duppa.

The artificial formation of succinic acid, starting with acetylene, having been proved, it is only necessary to start with that acid to prove the synthesis of tartaric acid from acetylene:—

$$\underbrace{C_4H_6O_4}_{\text{Succinic acid.}} + 2Br_2 = \underbrace{C_4H_4Br_2O_4}_{\text{Dibromosuccinic acid.}} + 2HBr$$

$$\underbrace{C_4H_2Ag_2Br_2O_4}_{\text{Argentic dibromosuccinate.}} + 2(H_2O) = \underbrace{C_4H_6O_6}_{\text{Tartaric acid.}} + 2(AgBr)$$

The speaker then proceeded to show how the synthesis of the organic alkaloids could be effected from inorganic materials.

In the first place the fact that cyanids can be produced by heating carbon in presence of nitrogen and an alkali, is well known. The next step is to procure prussic acid by distilling cyanids with acids. From pure prussic acid, methylamine, the simplest of the primary monamines, can easily be obtained, either by the aid of nascent hydrogen, or free hydrogen in the presence of spongy platinum.

$$\underbrace{CHN}_{\text{Prussic acid.}} + 2H_2 = \underbrace{CH_5N}_{\text{Methylamine.}}$$

This equation has been realized by both the methods given above, the first by Mendius, the second by Debus.

It is also evident that as alcohol can be obtained from acetylene, that all the ethylic, primary, secondary, and tertiary monamines of Hofmann can now be synthetically formed. The steps being, (1) conversion of acetylene into olefiant gas; (2) passage of olefiant gas into alcohol; (3) alcohol into iodid of ethyl; (4) action of iodid of ethyl on ammonia.

Again, acetic acid it has been shown, can be prepared from carbonic disulphid. Now acetic acid, by the action of a red heat, can be made to yield a number of the homologues of olefiant gas. The latter by treatment with excessively strong hydriodic acid, become converted into the iodids of the alcohol radicals (Berthelot). By following up this last reaction with pentylene, heptylene, octylene, and nonylene, the speaker succeeded in obtaining pentylamine, heptylamine, octylamine, and nonylamine.

The direct ascent from acetylene to the coal tar colors was then shown according to the following equations:—

$$3(\underbrace{C_2H_2}_{\text{Acetylene.}}) = \underbrace{C_6H_6}_{\text{Benzol.}}$$

$$\underbrace{C_6H_6}_{\text{Benzol.}} + HNO_3 = \underbrace{C_6H_5NO_2}_{\text{Nitrobenzol.}} + H_2O$$

$$\underbrace{C_6H_5NO_2}_{\text{Nitrobenzol.}} + 6(FeO) + H_2O = \underbrace{C_6H_7N}_{\text{Aniline.}} + 3(Fe_2O_3)$$

$$\underbrace{C_6H_5Br}_{\text{Bromobenzol.}} + \underbrace{CH_3Br}_{\text{Methylic Bromid.}} + Na_2 = \underbrace{C_7H_8}_{\text{Toluol.}} + 2NaBr$$

$$\underbrace{C_6H_7N}_{\text{Aniline.}} + \underbrace{2(C_7H_9N)}_{\text{Toluidine.}} = \underbrace{C_{20}H_{19}N_3}_{\text{Rosaniline.}} + 3H_2$$

These transformations were all described at length. In effect acetylene passed through a red hot tube becomes polymerized into benzol.

The passage of toluol into nitro-toluol and toluidine is omitted in the above equations, because the reactions are identical in kind with those of benzol into aniline.

In describing benzol, experiments were shown illustrating the density of its vapor as compared with air. In one of these, benzol was poured into a large beaker containing a hot iron; at first the benzol assumed the spheroidal form, but, as the temperature fell, it became converted into vapor, which filled the beaker. A glass syphon was then introduced into the beaker, and the vapor drawn off as if it had been a liquid, and inflamed. The vapor descending through the syphon was then received into a warm beaker, from which it was decanted into another beaker in which it was inflamed.

The speaker then proceeded to show the way in which the synthesis of zinc-ethyl could be effected; it is, however, unnecessary to follow the equations in detail, because, having already explained the manner in which alcohol can be synthesised from acetylene, it is obvious that zinc-ethyl can be directly derived from that fluid.

Wanklyn's interesting synthesis of acetic acid from sodium-methyl was then shown to take place in accordance with the expression:

$$\underbrace{CH_3Na}_{\text{Sodium-methyl.}} + CO_2 = \underbrace{C_2H_3NaO_2}_{\text{Sodic acetate.}}$$

The method appears to be general, inasmuch as the same chemist has effected the synthesis of propionic acid:

$$\underbrace{C_2H_5Na}_{\text{Sodium-ethyl.}} + CO_2 = \underbrace{C_3H_5NaO_2}_{\text{Sodic propionate.}}$$

And substituting carbonic oxyd for carbonic anhydrid, we have—

$$2(CH_3Na) + CO = \underbrace{C_3H_6O}_{\text{Acetone.}} + 2Na$$

The speaker stated that one of the most interesting of the cases of synthesis recently accomplished was that in which Mr. W. H. Perkin had succeeded in producing artificially the odoriferous principle of new hay and the tonquin bean.

The delicious fragrance of new hay is entirely due to the presence of the sweet-scented vernal grass, *anthoxanthum odoratum*. It is the same substance which is the cause of the sweet smell of the woodruff, *asperula odorata ;* and the melilot, *melilotos officinalis*. It is also the flavoring ingredient in the *mai wein* of the Germans, which is perfumed with woodruff.

Until lately, nothing was known about coumarin, except that it was a colorless crystalline body, having the formula—

$$C_9H_6O_2.$$

The crystals of coumarin appear very beautiful under the influence of polarized light. The image of some artificial coumarin, which had been fused and allowed to crystallize in a plate of glass, was then thrown upon the screen, and the light being polarized by the aid of Nicol's prisms, the crystals assumed the most gorgeous and varying colors as the prisms were rotated.

The clue to its constitution was shown to be the circumstance that when heated with potassic hydrate it yields salicylic and acetic acids. The production of salicylic acid from coumarin was then shown experimentally, the presence of the acid being proved by its yielding a deep purple coloration with ferric chlorid.

Artificial coumarin was obtained from the hydrid of salicyl. By treatment with sodium it yielded hydrid of sodium-salicyl; this substance, heated with acetic anhydrid, gave hydrid of aceto-salicyl. This last substance was then distilled with acetic anhydrid and sodic acetate, and when the temperature reached 290°, the distillate solidified to a mass of crystals of pure coumarin, having all the fragrance and beauty of that obtained from the tonquin bean.

The speaker then submitted that the assertion he had made at an early period of his discourse that there was no natural barrier between organic and inorganic chemistry, had been amply proved by the instances he had brought forward. He said that they had studied together that evening several cases where, starting from inorganic matter, they had ascended step by step until they had reached some of the most complicated bodies secreted by animals and vegetables. What, he said, could be more distinctly inorganic than nitrogen, carbon, and oxygen ? What more distinctly an animal secretion

than urea? What more completely inorganic than acetylene? What more distinctly vegetable in origin than coumarin?

Chemists have then, so far, done what a very few years ago would have been regarded as possible only by aid of the vital force. A true organized substance, he said, is so definite that we can almost invariably determine its molecular weight, and it is generally crystalline. But when we come to the tissues we are dealing no longer with organic substances, but with organized beings, and feel that we are approaching the barriers which separate the study of life from the study of matter. The bonds which unite them are so close that we cannot imagine life *without* matter, and it is equally difficult to conceive the assumption of vitality *by* matter; but we must never cease to look anxiously for the solution of the problem. The impossible is a horizon which recedes as we advance, and the *terra incognita* of to-day will to-morrow be boldly mapped upon every schoolboy's chart!

ART. XXXII.—*Notes on the Caucasus;* by Capt. F. VON KOSCHKULL. (Communication addressed to Prof. J. S. NEWBERRY, and translated by him for this Journal.)

(Continued from page 222.)

ASIDE from the ores which have been mentioned and which are associated with the igneous and crystalline rocks, the sedimentary formations also contain minerals of value.

The inferior strata of the Jurassic formation include important beds of coal, which are found on both slopes of the main chain of the Caucasus, the richest deposits being in the northwestern portion of the belt between Mt. Elbruz and Mt. Tisent. In the northern part of this area, coal has been discovered in the valleys of the Kuban and its affluents, Maraukle, Zelentschuk, Urup, Laba and Belaya. During the last ten years coal has been mined on the Kuban to the amount of about 4,000,000 kilograms per annum.

On the southern slope of the mountains, the beds of coal crop out on the banks of the upper Rion and its tributaries from the north, and have an aggregate thickness of about 28 feet. Except an insignificant quantity of a peculiar quality of coal, of which the inhabitants make ornaments, rosaries, buttons, brooches, etc., the coal of the Rion is not yet mined, the abundance of wood in that region fully supplying the present want of fuel; but with the construction of the proposed railroad from the Black sea to the Caspian these rich deposits will undoubtedly be brought into use.

The Jurassic strata of the Caucasus also contain rich deposits of sulphur. These are found in the eastern part of the mountain belt on the river Sulak. During the war with Russia the mountaineers obtained from this locality sulphur for the manufacture of gunpowder; but since their submission the mines have been entirely unworked.

Salt, alum, petroleum and asphaltum are met with in the Tertiary formation. The salt occurs in two forms, viz: that of rock salt, of which thick and wide-spread strata have been found, and that dissolved in or deposited from the water of salt lakes. The principal beds of rock salt are in the valley of the Araxis, both east and west of Mt. Ararat, and geologically are lower Tertiary. These deposits of rock salt have evidently been known and worked from the most remote period; as among the modern mines are numerous and extensive ancient workings of which no historical record exists.

In 1865, when engaged in a survey of the salt district, my attention was attracted by some of these old mines, which were regarded by the inhabitants as natural caves.

I soon satisfied myself, however, that they were the work of man, and resolved to explore them. My guides would fain have dissuaded me from carrying the plan into execution, as their imagination had peopled all these subterranean passages with evil spirits, of which they stood in great fear. Disregarding their superstitions, I penetrated one of the ancient adits, and partially explored what proved to be a very extensive and fairly well wrought mine, evidently of great antiquity. At the remote end of some of the galleries I found heaps of mined salt and hundreds of tools of various forms and sizes, either perfect or more or less worn and broken. These implements were for the most part picks or pick and hammer combined, varying from 5 to 15 inches in length, wrought with great labor and considerable skill out of a tough hornblendic rock. None of these tools were pierced for the insertion of handles, but all were encircled by grooves for the reception of withes or thongs. In this respect, as in the character of the material of which they were formed, resembling many of the stone implements of Europe, and being apparently the product of the same age, or more accurately speaking, of the same stage of intellectual development.

The salt lakes of which I have spoken occur on the peninsulas of Taman and Apscheron, and on the plains bordering the rivers Terek and Kuban. From the concentration of the saline solutions of these lakes in summer, on many of them a crust of salt forms, which attains a thickness of from three to six inches. This crust is collected by the inhabitants for use.

The total production of salt in the Caucasus is about 24,000,000 kilograms of rock-salt, and 16,000,000 kilograms of lake-salt per annum.

Aside from the salt lakes to which I have referred, there are others in the valley of the Kur and Araxes, of which the waters contain large quantities of sulphate of magnesia and carbonate of soda.

Alum stone, which is very rich in alum, occurs on the northern slope of the Little Caucasus, and there is produced from it a yearly product of about 16,000 kilograms of alum.

Of the minerals of the Tertiary formation, by far the most important are petroleum and asphaltum. All the accumulations of these substances are in the upper Tertiary strata, and are distributed geographically in several districts, of which the most important are the extremities of the great Caucasian chain, which form the peninsulas of Taman and Abscheron; on the flanks of the mountains on the north, in the valleys of the tributaries of the Kuban, and of the river Saundga (Sundscha); on the southern slope, in the valleys of the Rion and Kur.

A considerable degree of system is noticeable in the distribution of the springs of petroleum in each of these districts, and they are found to bear certain relations to the principal lines of upheaval which traverse them. Sometimes the springs issue from the summits of the anticlinal axes, and sometimes in parallel lines along the slopes of the upturned strata. The petroleum of the Caucasus consists of two well marked varieties; one, very fluid, of a light yellow color, found only on the peninsula of Abscheron; the other, dark brown in color, varying in density from that which is very thin to mineral tar and asphaltum. Carburetted hydrogen gas issues from all the petroleum springs, and is most abundant where the petroleum is lightest.

The oil springs of the Caucasus have been known and the oil collected from them for ages. Upon the peninsula of Abscheron, and on the banks of the Saundga and Kur, the petroleum is collected in pits of greater or less depth excavated in the sandy strata of the Tertiary age. The deepest of these pits descend from 70 to 100 feet from the surface, while the shallowest are only two feet.

In these pits the oil is accompanied by water, from which it is dexterously separated by skimming. The instrument by which this is effected is a sack of green hide, the mouth encircled by an iron ring, the sack being suspended by a cord.

As a general rule the wells are skimmed once a day. The quantity of petroleum obtained from the different pits is very variable, but is nearly constant for the same pit. The opening

of new wells in the vicinity of old ones seems not to affect the yield of the latter, so that the productiveness of a given area depends directly on the number of wells which it contains. This fact has determined the method pursued in the collection of petroleum on the island of Tschelaken and on the eastern shore of the Caspian, where to obtain a large quantity of oil 20,000 wells have been sunk, but none to any great depth. The Persians, who were the first to collect the oil of the peninsula of Abscheron, seem to have followed the same system of exploitation.

The number of wells dug there is very great, and they are very closely approximated. In 1863, a new well was sunk by the side of one which had for centuries yielded about 1,600 kilograms of petroleum per day. The new one now produces 19,200 kilograms every twenty-four hours without affecting in the least the yield of the old well.

In 1865, the method pursued with so much success in America in the exploitation of petroleum was introduced into the Caucasus and with complete success. In a locality selected by myself, near some oil springs in the valley of one of the tributaries of the Kuban, a well was commenced in the above mentioned year. At the depth of 40 feet encouraging signs were met with, and in Feb., 1866, when the boring had reached a depth of 242 feet, the petroleum burst out in a jet which was maintained at a height of 42 feet until controlled.

At first the production of this fountain well was 32,000 kilograms per day, but the yield gradually diminished to about one-half that amount. There have since been periods when the flow was entirely arrested, but apparently in consequence of the clogging of the well, as when cleaned out, the normal flow was resumed.

During 57 days in 1866 during which the flow from this well was carefully measured, the production was 880,000 kilograms of petroleum, with one-tenth of that quantity of water; and during 196 days of service this well has produced 2,160,000 kilograms of oil.

The temperature of the oil as it flows from this well is 7° Reaumur, that is to say, 3° less than it should be according to the geothermic law for a liquid drawn from a depth of 242 feet below the surface. Can this depression of temperature be attributed to the absorption of heat in the conversion of a portion of the petroleum into gas?

I learn by a letter recently received from the Caucasus that a new well sunk in the vicinity of that just described, having reached in November last the depth of 258 feet, opened a fissure from which the oil issued with such force as to form a jet 60 feet in height, and yielding 64,800 kilograms of oil per day.

In addition to the petroleum produced by the wells and springs in the valley of the Kuban, of which no accurate measurement has yet been made, the total annual yield of the oil region of the Caucasus may be estimated as follows:

		Kilograms.
1.	Petroleum produced on the peninsula of Abscheron,	8,640,000
2.	" " in the valley of the Kur,	192,000
3.	" " " " " Saundga,	320,000

In all the oil districts of the Caucasus in the vicinity of the oil springs, deposits of asphaltum and ozokerite have been discovered. Not long since a beginning was made in the use of these substances for the manufacture of paraffine, and the amount now obtained from this source is 100,000 kilograms per annum.

No sketch of the physical geography of the Isthmus of the Caucasus can be considered complete which does not include some notice of the action of subterranean forces which even now are producing many striking phenomena. The continued activity of the causes which in former periods so completely changed the topography of this region, is manifested by frequent earthquakes, by eruptions of mud volcanoes, and by numerous thermal springs.

As regards the earthquakes, the Isthmus of the Caucasus may be divided into several sections, each of which has its center of action. On the northern slope of the great Caucasian range, one of these shaken districts lies north of Mt. Elbruz, including the area drained by the tributaries of the rivers Kuban, Kuma and Malka, with its center near Pjatigorsk. The other northern district includes all the space on the southeast of the river Terek, with its center at Grognaga. On the south side of the Great Caucasus one district is formed by the lower valley of the Kur, with its center near the city of Schemakha. The second district includes the middle portion of the valley of the Kur, with its center at Tiflis; while the third district comprises the northern part of Persia and Asia Minor, having its center in Mt. Ararat. Earthquakes are so common in the Caucasus that they may be almost said, like the sunrise, to form part of the daily experience of the inhabitants.

The severity of these earthquakes varies greatly; some are terribly destructive, as was that which a few years since destroyed the fortress of Nazrau on the north side of the Caucasus, and that other which nearly demolished the city of Schemakha.

The mud volcanoes now, or recently in action, are for the most part confined to the extremities of the great Caucasian chain, that is, to the peninsulas of Abscheron and Taman.

These mud volcanoes generally form conical hills from 200 to 1,000 feet in height, on the summits of which are craters with many cones of eruption. The diameter of the craters is sometimes considerable (as much as 700 feet).

The ordinary and moderate action of these volcanoes is sometimes interrupted by paroxysms of great violence, attended by copious eruptions and by earthquakes. The phenomena displayed by one of these volcanoes when in vigorous action was first described by the famous naturalist and traveler, Pallas, in 1793. This was situated on the peninsula of Taman, where precisely similar exhibitions may be now observed. New cones are also produced now, as formerly, and it has been observed that they are formed along certain well defined lines which correspond accurately with the principal axes of elevation which traverse the Isthmus.

On the peninsula of Taman the ejections from the mud volcanoes are found covering many of the mounds which contain the tombs of the ancient Greek colonists who inhabited this region. At the other extremity of the Caucasus in May, 1861, an island was formed by volcanic eruptions in the Caspian Sea, between the peninsula of Abscheron and the mouth of the Kur. In the course of a few months this island was washed away by the waves.

The thermal springs to which I have alluded, are for the most part confined to the flanks of the main chain and of the Little Caucasus. Yet they are sometimes found in the mountains at a considerable elevation. All these springs form certain groups disposed in lines parallel with the great axes of elevation. The water of the hot springs sometimes reaches the temperature of 72° Reaumur, but in this respect as well as in regard to the matters held in solution, there are marked differences between the different springs even when closely approximated.

The most remarkable groups of springs are on the northern side of the principal chain of mountains. 1st. Those north of Mt. Elbruz, near the city of Pjatigorsk, interesting from the number of the springs, and the peculiarity and diversity of their waters. 2nd. On the river Soundja. These are sulphur springs, and some of them very hot (72° Reaumur). 3rd. Along the river Saulak, also sulphurous, with a temperature of 42° Reaumur. 4th. On the Kuban; like the last sulphur springs, and having the same temperature (42° Reaumur).

South of the Great Caucasian chain are three groups of hot springs, one in the city of Tiflis, sulphurous water, with a temperature of 30° Reaumar; another near the city of Schemakha; the third in the mountains of Karthlo-Imeritia; this

latter group is remarkable for the diverisity of character exhibited by the different springs.

Even in this brief description of the Isthmus of the Caucasus, it seems necessary that something should be said of the relations which exist between the orography and the climate, population and productions.

The principal chain of the Caucasus divides the country into two districts, which present marked differences of climate.

The plain drained by the rivers Terek and Kuban passes imperceptibly on the north into the steppes of Southern Russia. The southeastern portion of this plain bordering on the Caspian Sea is represented by broad sandy surfaces and extensive "salt-pans;" while the interior and western portions consist of low prairies, marshes and mud flats. In consequence of these conditions this plain is entirely abandoned, during the winter, to the cold and snows brought by the north winds from the plateaus of Southern Russia and from the Ural Mountains. The proximity of the Black Sea scarcely serves to moderate the severity of this season, and on the banks of the Kuban and Terek the snows of winter are deep and the mercury often falls to $-20°$ Reaumur. During the summer, on the contrary, fair weather prevails, and in this portion of the year the surface of this plain, destitute of forests, is heated to an almost insupportable degree. At times refreshing winds blow from the south and southeast, coming from the mountains or from the Caspian, bringing rain storms and cooling the earth and air. The summer is, however, generally excessively hot, the mercury rising to 30° Reaumur.

The southern portions of the Caucasian Isthmus are completely sheltered from the north winds by the great mountain barrier to which reference has been so frequently made. On the east and west this region is open to the influences of the Caspian and Black Seas, while its climate is somewhat influenced by the wall of mountains which in Northern Persia and Asia Minor bound it on the south. In consequence of these circumstances no considerable degree of cold is felt here. This is specially true of the valleys of the Rion and Kur, where frosts are very rare, and where the mercury never falls below 5° R. Snow almost never covers the country, and when it falls remains but a few hours. The winter is short as well as mild, and generally consists of but a brief rainy season. On the other hand the summer is long and warm, and but for the influence of the neighboring seas the heat would be unbearable.

The mountains of Karthlo-Imeritia exert an influence on the climate of the valleys of the Rion and Kur which deserves to be noticed. From its transverse direction across the great

valley—if such it may be called—drained by the Rion and Kur, it forms a barrier limiting the influence of the Black Sea on the east, and of the prevailing southeast winds which sweep the valley of the Kur. To the protection afforded by this chain the luxuriance and humidity of the valley of the Rion must be ascribed, as but for this obstacle the southeast winds of summer, having parted with their moisture in the lower part of the valley of the Kur, would carry their dessicating influence even to the shores of the Black Sea. The climate of the Little Caucasus, and the valley of the Araxes, on account of their elevation, is a little colder in winter than that of the valleys of the Rion and Kur; but in summer it is perhaps as hot.

The proximity of the Isthmus of the Caucasus to the cradle of the human race, its climate, the richness of its flora and fauna, its mineral resources, and finally the beauty of its scenery, have made it the favorite abode of many nations. Not only do the writings of the ancient historians, Herodotus and Strabo, prove that this country was inhabited at a time very remote from the present, but the traces of human occupation of still earlier date scattered over all portions of it, indicate that anterior to the historic period it was possessed by various races greatly differing in their degree of civilization.

Stone implements are frequently found in the valley of the Araxes, and in the old salt mines of the same region; mines which are regarded as the most ancient known, and as probably the oldest monuments of human industry that now exist.

In the mountains of Karthlo-Imeritia are excavated ("*troglodyte*") houses, and an entire city has been discovered wrought out of the rocky walls which border the narrow valley of the river Ljokhwa, an affluent of the Kur. North of Mt. Ararat, on the summit of a hill, are to be seen the ruins of the city Armawyr, which, according to historical records, was the first capital of Armenia, more than 2,000 years B. C. This city was then situated on the banks of the Araxes, but the river now passes at the distance of seven or eight kilometers. One of my colleagues, M. Guileff, has lately found in the narrow valleys of the Caucasus, not far from the eastern shore of the Black sea, certain graves known in Europe under the name of Celtic tombs. Among the inhabitants of this part of the Caucasus the tradition exists "that these so-called tombs were the habitations of a people who lived here, and that they were built for them by their neighbors the giants." On the peninsula of Taman an embankment or rampart exists, which is attributed to the Cimmerians, who, according to the ancient chronicle, inhabited the shores of the Euxine sea. Scythian remains are found throughout southern Russia, and as far south as the base of the Great Caucasus.

Well marked traces of the presence in this country of a people far advanced in civilization have remained to us from the time of the early Greek colonies. These colonies occupied all the valley of the Rion (the ancient *Phasis*), the peninsulas of Taman and Kertsch, and a portion of the course of the Kuban (the ancient *Hypanis*). That these were rich and flourishing colonies we learn not only from the narrative of the expedition of the Argonauts, but much more conclusively from the relics which they have left behind them, and which clearly indicate wealth and a cultivated taste. These relics are usually found in tombs, and the tombs in sepulchral mounds. They consist of pottery, implements, arms, ornaments in gold or silver, coins, statues, etc.

In the year 1864, I had occasion to assist in the opening of two royal tombs which had been found in one of two tumuli, called the twin tumuli, situated upon the peninsula of Taman. When by boring a mass of masonry had been detected in one of these tumuli, two horizontal galleries were carried through it, crossing each other at right angles, by means of which two separate tombs were discovered. These tombs contained the following relics: In the middle of each was a sarcophagus of cypress-wood, in the form of an oblong box without cover, and standing upon small feet. The external surfaces of these sarcophagi were covered with a carved and gilded ornamentation. In each was a skeleton which crumbled into dust at the slightest touch, also the remains of clothing and sandals, and various golden ornaments. Among these were masks made of thin plates of gold, which had been molded to the features so as to represent the physiognomy of the wearers. Above them were two crowns, which with the masks were indicative of a difference of sex in the persons buried. One of these crowns represented a garland of oak and laurel branches. The second also formed a garland, but composed of ears of wheat, and flowers. The golden ornaments found in the sarcophagus of the female were richest and most numerous; as for example, beneath her mask was a collar formed of several rows of chains interlaced. To these chains were suspended charms representing divinities, animals and other fantastic figures. In the same sarcophagus were found bracelets for the arms and limbs. The combined weight of the golden ornaments it contained was 32 kilograms. In the sarcophagus of the male, besides the mask and crown, the only ornament found was a girdle also of gold. The other objects contained in the tomb clearly indicated the difference of sex which has been alluded to. In one there were placed around the sarcophagus and along the walls urns, vases, perfume bottles, lacrymatories, metallic mirrors, and shells con-

taining pigments. There were also statues in terra-cotta representing the following divinities: Cupid, the Three Graces and Venus, besides a large statue in white marble of the goddess Aphrodite. In the other there were amphoræ, vases, platters of different sizes of black pottery ornamented with red figures, arms eaten up by rust, and small figures in terra-cotta representing the goddess Diana. Both the tombs in which these relics were found were built of dressed stone, the material having been obtained from the quarries of Tertiary limestone on the peninsula of Kertsch. They were not arched above, but the ceilings were composed of courses of stone which overlapped till they met in the center. These tombs were placed a little above the base of the tumulus, which was of a conical form, from 35 to 45 feet in height and 70 feet in diameter, and composed of successive layers of carbonaceous soil, of sand and fragments of broken vases, mixed with ashes and charcoal. Among the fragments of pottery were many which seemed to have formed part of a large and complicated design. This excited a desire to reunite them, and since they were scattered throughout the whole mound, to accomplish this end it became necessary to sift the entire mass. This gigantic labor occupied 150 men for several months, and resulted in complete success. From the broken fragments were reconstructed a large vase and a flat dish bearing different designs, but referring to one episode in the history of Greece. Upon the dish was portrayed the meeting of Paris and Helen, and upon the vase the abduction of the beautiful wife of Menelaus. From their size, the beauty of the conception and the execution of the ornamentation, this vase and dish are unquestionably the finest specimens of the kind yet discovered.

The mounds containing tombs similar to those described are mostly found on the peninsula of Kertsch, in the suburbs of the town of the same name, which was formerly the site of Panticapæum, and on the peninsula of Taman, near the sites of the ancient cities of Corocondama and Phanagoria, of which almost no other traces remain.

After the remains of the Greek colonization come those which belong to the propagation of Christianity. Of this epoch we have traces in nearly all parts of the Caucasus. The Genoese occupied not only the peninsula of the Crimea, but they were scattered through the valley of the Rion, and over the northern slope of the Great Caucasian chain north of Mt. Elbruz. The pass of Moroukh served them as a route of intercommunication between the colonies north and south of the mountains. Along this route, and in general in all the western portions of the Isthmus are found ruins of churches and monasteries, sometimes with paintings on the walls, sepulchral

monuments, inscriptions, ornaments and utensils. The most remarkable remains of the period of the propagation of Christianity among the Armenians and Georgians are the ruins of the city of Ani, the ancient capital of Armenia, situated on the banks of the river Arpa-tschai.

Nearly all the ancient remains found in the eastern part of the Caucasus belong to the epoch of the domain of the Persians and consist of ruins of mosques and caravanseras, palaces and fortifications, aqueducts, and canals.

The height of the mountains, and the isolated and enclosed character of the valleys of the Isthmus of the Caucasus may be considered as the principal cause of the diversity in the population of the Caucasus and of the tenacity with which national characteristics have been maintained.

The northwest part of the Caucasian chain, as far east as Mt. Elbruz, is inhabited on the north side by the Netokhasch, Schapsaughes, and Abadzek; on the southern slope by the Oubjiskh and Abkhaz.

After the subjugation of this portion of the Caucasus, in 1864, the greater part of these tribes, except the Abkhaz, quitted the country, and it has since been occupied only by the Russains. All the tribes mentioned speak different languages.

Judging from certain customs which are retained by these people, we are led to believe that during the time of the Gennis colonies Christianity spread widely among the inhabitants of this part of the Caucasus, but now they are all Mohammedans, and belong to the sect of the Sunnites.

Between the meridians of Elbruz and Tebaulas-mtha, on the northern slope of the mountains, and along the river Terek and its tributaries are some Russians who form military colonies; the original population consisting of the inhabitants of Kabarda and Tschetschnia. The valleys among the mountains in this part of the chain are inhabited by the Ossethes and the Torschethes.

On in the basin of the Rion are found the Mingrelians and the Imerethians, in the valley of the Kur, the Georgians, and further south in the mountains of Kathlo-Imeritia and the Little Caucasus, the Gourians and Armenians. All these speak different languages, and are Christians, except the inhabitants of Kabarda and Tschetschnia, who are Mohammedans. The southeastern portion of the Isthmus of the Caucasus is occupied, in the valley of the great mountain chain by a population known under the general name of the inhabitants of Daghestan.

This population scarcely represents a single nation, but is rather composed of several tribes who inhabit different valleys, speak different dialects of one language, and who are all Mohammedans of the Sunnite sect. The southern slope of the

eastern part of the Caucasian chain and the Little Caucasus are inhabited by a people descended from the Persians, who speak one language, are Mussulmans of the sect Slhüte. In addition to the indigenous tribes which have been enumerated, there are in the Caucasus many Russians and Germans who form communities scattered through all parts of the country.

The occupation of the Isthmus of the Caucasus for ages by so many nationalities, has made it the scene of incessant strife, by which its productiveness and prosperity, so highly favored by nature, have been greatly impeded.

Except the working of mines and the manufacture of metals, the industry of the country is absorbed in agriculture, stock raising, fishing, rearing of silkworms, horticulture and the manufacture of wine.

At the north, on the plains drained by the Terek and Kuban which are without forest, and have a dark, rich soil, wheat is generally cultivated—rye sparingly, and barley, oats, and buckwheat are grown.

Along the rivers when irrigation is easy, fruit and vegetables are raised; but only in the vicinity of the cities Pjotigorsk and Kyzljar is the vine cultivated and wine made.

As the vast plains bordering on the Terek and Kuban consist largely of prairies, the raising of horned cattle and horses is there extensively followed.

In the Great and Little Caucasus, in consequence of the physical conditions which prevail there, the inhabitants devote themselves to the raising of sheep, and the cultivation of the soil is of secondary importance.

In the southern portions of the Isthmus, and especially in the valleys of the Rion, Kur and Araxis, where nature has been more generous in her gifts, the range of productive industry is much extended. As the climate is mild, and the soil good, it may be said that the productiveness of this region is dependent simply on the amount of water available for irrigation. Beside wheat, barley and buckwheat, rice, cotton and maize are raised here. Horticulture is also largely practised, and the cultivation of the vine assumes great importance, formerly the principal occupation of the Cakhethii who live along the Alazan, one of the tributaries of the Kur.

The cultivation of tinctorial plants such as indigo and saffron is followed on the western shore of the Caspian.

In the localities most favorable to the cultivation of fruits much attention is also given to the rearing of silkworms. The most important centers of this industry are the cities of Schemakha and Naukha.

Upon the shores of the Caspain and Black seas, and the sea of Azoff, especially on the peninsula of Taman, and at the

mouths of the Terek and Kur are important fisheries, which compensate in some degree the inhabitants of these districts for the marshy and unproductive nature of the surface.

Since the Russians have gained control of the Caucasus, the Government has taken great pains to foster all forms of productive industry, but its efforts have been much impeded, and often completely thwarted by the perpetual war which the mountaineers have maintained. In 1864, however, the last of the opposing forces were overcome and with the general restoration of peace it is hoped that the development of the resources of the country will advance with more rapid strides. This may be the more confidently expected since all the power of the government hitherto absorbed by war is now directed toward the organization of society, and the amelioration of the condition of the country. Within the last few years the Russian authorities have been engaged in the emancipation of the serfs, the organization of a system of public instruction, in repairing and constructing canals for irrigation, roads, etc. Among these provisions for the public good, one of the most important is the proposed rail road from the Black Sea to the Caspian. This will give a new impetus to the intellectual and industrial development of the country, hitherto so much retarded by the want of unity and harmony among its heterogeneous population.

Note.—A convenient map for consultation in connection with this article may be found in Haxthausen's Transcaucasia, (2 vols. 8vo. Leipsic, 1856.) A profile of the Caucasus range, with the heights of numerous peaks, may be found in Petermann's *Mittheilungen* for 1859, (tafel xii,) based upon the data of General Chodzko. Some of Abich's papers on the geology of the Caucasus are given in the Berlin Zeitscrift für Erdkunde. One of these, in the volume for 1853, is illustrated by a profile, colored geologically, of the slope of the Caucasus, north from Elbruz toward Beschtau.—EDS.

ART. XXXIII.—*Notes on Mr. Charles Stodder's paper entitled "Nobert's Test-plate and modern Microscopes," published in the American Naturalist*, April, 1868; by W. S. SULLIVANT.

Mr. STODDER'S paper above cited is full of interest to the microscopist. In it is announced the resolution of lines on the Nobert Test-plate* which are as close together as the $\frac{1}{112.888}$ of an English inch, and much exceed in fineness those heretofore seen by other observers.

* The plate used in the trials detailed by Mr. Stodder is one of nineteen bands, the first being ruled to the $\frac{1}{1080}$ of a Paris line or to the $\frac{1}{111.48}$ of an English inch, each band increasing by 500 so that the 19th band is ruled to the $\frac{1}{10000}$ of a Paris line or to the $\frac{1}{112888}$ of an English inch.

From Mr. Stodder's brief sketch of what had been previously done in the separation of lines under the microscope, it appears that Ross, De la Rue, and Sullivant and Wormley after extended and exhaustive experiments on the Nobert test plate, failed to resolve lines closer together than about the $\frac{1}{8\,3\,5}$,$\frac{1}{0\,0\,0}$ of an inch. It appears also that Nobert himself has never been able, with the highest powers, to see lines on his own test-plates closer together than the $\frac{1}{8\,1\,4}$,$\frac{1}{0\,0\,0}$ of an inch.

On the other hand, the late Professor J. W. Bailey claimed to have seen lines the $\frac{1}{1\,2\,0}$,$\frac{1}{0\,0\,0}$ of an inch apart; and Messrs. Harrison and Sollitt claim to have measured striæ on the diatom *Amphipleura pellucida* having an interval of the $\frac{1}{1\,3\,0}$,$\frac{1}{0\,0\,0}$ to the $\frac{1}{1\,3\,0}$,$\frac{1}{0\,0\,0}$ of an inch, and gave it as their opinion that lines as close as the $\frac{1}{1\,7\,5}$,$\frac{1}{0\,0\,0}$ of an inch could, with proper means, be resolved. The above is learned from Mr. Stodder's paper.

There is no reason to question the results, such is their close accordance, obtained by the observers first mentioned, but in reference to the claims made by Prof. Bailey and Messrs. Harrison and Sollitt, it may be remarked that Prof. Bailey, though one of the most accomplished physicists of his day, was, owing doubtless to defects in the apparatus used, quote inaccurate in some of his micrometrical measurements;* and with regard to the alleged measurements of the striae of *Amphipleura pellucida* by Messrs. Harrison and Sollitt, it is sufficient to say that it is now the generally received opinion among microscopists familiar with that diatom, that no true striæ have yet been seen on its frustules.†

From the foregoing it is not an unwarrantable inference that anterior to the experiments reported in the paper under notice, no satisfactory evidence is on record that lines closer than about the $\frac{1}{8\,3\,5}$,$\frac{1}{0\,0\,0}$ of an inch, either on Nobert's test-plate or any other object, have been resolved. This being the limit reached by previous observers, the skill in manipulation and in the management of the illumination, &c., that brings to view, so distinctly and palpably, lines ruled to the $\frac{1}{1\,1\,2}$,$\frac{1}{0\,0\,0}$ of an inch that they have actually been counted and measured and found to

* He assigned to *Pleurosigma Spencerii* a striation of $\frac{1}{1\,2\,0\,0\,0\,0}$ to $\frac{1}{2\,0\,0\,0\,0\,0}$ of an inch, the real striation being only about $\frac{1}{3\,3\,0\,0\,0}$ of an inch. (This Journal, Jan., 1856). The striae of *Grammatophora subtilissima* are given by him as $\frac{1}{1\,2\,0\,0\,0\,0}$ to $\frac{1}{2\,0\,0\,0\,0\,0}$ of an inch apart instead of about $\frac{1}{7\,5\,0\,0\,0}$, the true distance, (this Journ., Jan., 1851.)

† Mr. Sobb, (*Carpenter on the Microscope*, 3d ed., p. 198) claims to resolve *Amphipleura pellucida*. Prof. H. L. Smith, of Gambier, Ohio, whose valuable additions to microscopical apparatus are well known, has given much attention to this diatom; he recently witnessed Mr. Sobb's alleged resolution of its frustule, and considers the lines exhibited as spectral or spurious, and such, he states, is the opinion of Mr. Wenham.

correspond with the registration on the test-plate (p. 100), challenges the admiration of all interested in microscopy, and proves by the inexorable test of experiment, that the resolution of such lines is not incompatible with the physical properties of light, as has been asserted by Fraunhofer and other writers of authority on optics.

The grade of some of the objectives with which these resolutions were made is scarcely less remarkable than the resolutions themselves. Reliance was placed, not so much on those beautiful achievements in optical art, the $\frac{1}{25}$ and the $\frac{1}{30}$ lately sent out by Powell and Lealand, as on objectives of a medium grade, such as a $\frac{1}{6}$ *immersion* and a $\frac{1}{8}$ *dry* by Tolles. Mr. Stodder says "these trials show conclusively that it is not the great power of the objective that is important, for in many of the trials here reported, the lower powers have given the best results, but the skill of the opticians in making the instrument."

The objectives of Mr. Tolles unquestionably rank among the best, but it may be doubted if evidence exists, unless it be these trials reported by Mr. Stodder, of their superiority to those made by Spencer in this country, and by Powell and Lealand and others in England. Hence it is a fair inference that the failure of previous efforts on the highest bands of the Nobert test-plate is attributable to causes other than an incapacity in the objectives used.

Mr. Stodder would have done an acceptable service to those who may hereafter attempt such investigations, had he gone somewhat into detail as to the system of illumination, the auxiliary apparatus, &c., adopted by himself and other gentlemen whose experiments he reports.

Such success in carrying up the resolvability of lines so far beyond the point at which well-directed efforts, sustained by theory, had placed it, will doubtless attract other observers to this field of research, where, among other sources of deception, none will be found more prolific than the spurious or spectral lines always shown by the objective working with oblique light and under a strain; for it may well be supposed that any objective, especially one so low as a $\frac{1}{5}$th would be strained in the resolution of lines ruled to the $\frac{1}{112,000}$ of an inch.

It is well known to all familiar with this subject, that it is impossible to distinguish, by their mere visual appearance, the spurious from the true lines on the highest bands of the Nobert plate. No lines, therefore, should be entitled to full confidence as being the true lines, unless verified by the micrometer, that is, counted, measured, and found to correspond with the registration on the test-plate.*

* It is here assumed that the lines are ruled on the test-plate as indicated by Nobert; no error having yet been found on any of his plates.

Mr. Stodder remarks "it has been said that the resolution of lines to the eye, implies the ability to count them, but this, I think, is a fallacy," and illustrates his remark by the difficulty of counting the pickets on a fence, at a given distance. The difficulty in both cases could perhaps be surmounted to the extent necessary, by enlarging the visual angle under which the lines and pickets appear to the eye, viz: by adding to the amplification of the microscope, and shortening the distance to the fence.

Among the highest bands of the Nobert plate, owing to the want of perfect flatness of field inseparable from the best objectives, a portion only of the width can at one time be brought into exact focus. If that portion, however, is measured and its lines resolved under a suitable amplification, the data are obtained for the solution of the problem in hand, namely, the determination of the distance apart of the lines thus separated.

In another extract from Mr. Stodder's paper he says "in counting lines of such exquisite fineness, either the micrometer or the stage must be moved, and it is next to impossible to construct apparatus that can be moved at once $\frac{1}{1000}$ of an inch and no more." This remark, coupled with the one above cited in which the supposed ability to count lines resolved to the eye is deemed a fallacy, suggests the inquiry, how was it satisfactorily ascertained that the *true* lines on the 19th band, ($\frac{1}{1125}$) were seen (page 99) with a $\frac{1}{8}$ objective and under an amplification of 550 diameters?

Besides the low grade of the objective, a noteworthy feature in this performance, is the low amplification employed. Heretofore it has been found no easy task to confirm by count and measurement, lines $\frac{1}{25000}$ of an inch apart, resolved by high-grade objectives, under an amplification of 6,000 diameters.

Mr. Stodder very correctly remarks that an exact and controllable motion in the micrometer or the stage for the purpose of counting the lines of the highest bands, is next to impossible. But in the mere counting of lines, amplification is the important requisite, not the micrometer, the office of which is simply to measure that portion of the width of a band in which the lines can be counted. Motion in the measuring apparatus —the cobweb-micrometer, for instance—is required for the purpose mainly of setting the spider-lines so as to embrace accurately, and thus measure the portion of the band above mentioned, not for the purpose of measuring off, line by line, one at a time, the Nobert lines, as Mr. Stodder seems to require: this, indeed, as before said, would be next to impossible.

But there are other methods of measurement, and it may be safely asserted that whatever lines the objective can resolve,

amplification with illumination for counting them, and apparatus for measuring the space in which they are counted, are all within the reach of the microscopist.

Mr. Stodder's views on the micrometry of the Nobert lines, are certainly untenable. He invests the subject with insurmountable difficulties, and thus seems to ignore the only certain and reliable means of determining the nature, whether real or spectral, of any lines that may be seen on the high Nobert bands.

His paper, nevertheless, will form an interesting part of the literature of a subject that has long attracted much attention, namely, the limit of the resolvability of lines under the microscope. The experiments recorded by Mr. Stodder go far toward determining this limit. They show that there was an error in fixing it among lines about the $\frac{1}{85,000}$ of an inch apart. They also show that lines as close as the $\frac{1}{112,000}$ of an inch can be separated. These are the finest lines ever yet ruled on any test-plate. How much narrower an interval lines may have and still be resolved, cannot probably be determined with numerical precision, until the ingenuity of Nobert adds finer ruled bands to his test-plates.

In the meantime, microscopists will doubtless find "pleasant divertisement" in resolving with their $\frac{1}{5}$ths and $\frac{1}{6}$ths, the lines of the four or five highest bands of the present test plate; and they would do well in dealing with even these bands to bear in mind that "no other sense approaches in power of self-deception to that of sight; and that, especially when the eye is strained by an eager observer, and the imagination perhaps, plays under the pressure of a theory, it is quite possible, after a little, to see almost anything that is expected."

Note.—Since the above was in type the writer has been kindly presented by Dr. J. J. Woodward of the U. S. Medical department at Washington, with a series of beautiful photographs, recently made by his assistant Dr. E. Curtis, of all the bands of Nobert's 19-band test-plate. The first 15 bands are sharply and clearly resolved into their true lines; the 15th band, however, (which is ruled to the $\frac{1}{90,000}$ of an English inch) requiring a hand-glass, magnifying four or five diameters, to show its lines distinctly.

The resolving and photographing such extraordinarily fine lines rank first among any performances of the kind on record, and attest the remarkable skill of Dr. Curtis who has accomplished both so successfully.

The objective used was a $\frac{1}{25}$ inch made by Powell and Lealand; amplification 1,000 to 2,000 diameters. The photographs of the 16th, 17th, 18th, and 19th bands gave, as Dr. Woodward remarks, only false or spectral lines.

ART. XXXIV.—*Remarks on the nineteen-band Test-plate of Nobert;* by J. J. WOODWARD, Asst. Surgeon, and Brevet Lieutenant-Colonel U. S. Army.

THE January number of this Journal for 1861 contains an interesting article on the thirty-band test-plate of Nobert, by W. S. Sullivant and T. G. Wormley.

In this test-plate the lines of the first band are ruled $\frac{1}{1000}$th, those of the thirtieth band the $\frac{1}{8000}$th of a Paris line apart, measuring from the center of one line to that of the next.

Sullivant and Wormley resolved the first twenty-six of these bands, partly resolved the twenty-seventh, but failed to resolve satisfactorily the last three bands.

Nobert has since prepared a test-plate of nineteen bands, in which the lines of the first are the $\frac{1}{1000}$th, those of the second the $\frac{1}{1500}$th, of the third the $\frac{1}{2000}$th, and so on, those of the nineteenth band being the $\frac{1}{19000}$th of a Paris line apart.

In this new plate the fifteenth band corresponds precisely with the last band of the thirty-band plate, the lines being the $\frac{1}{8000}$th of a Paris line apart.

On one of these new plates Max Schultze * has succeeded in resolving the fourteenth band, Eulenstein of Stutgard has done the same, and Nobert himself has gone no further,† nor, so far as I know, has any other European microscopist.

Under these circumstances, Mr. Charles Stodder of Boston tells us that he and Mr. Greenleaf "saw the nineteenth band satisfactorily" with a Tolles' $\frac{1}{8}$th immersion of 170° angle, magnifying 550 diameters.

They did not count the lines, an operation which Mr. Stodder thinks is quite impossible.‡

For myself, having also seen lines which I thought real in the nineteenth band, with several objectives, and having satisfied myself both by counting and by having photographs taken of what I saw, that these were spectral or spurious, and not real lines, I am quite convinced that those which Messrs. Stodder and Greenleaf have seen are of the same nature, and hope these gentlemen will attempt to count the lines they see in the nine-

* Archiv für mikroskopische Anatomie. Bonn, 1863, p. 305. His words are: "Bei schiefem Licht bin ich mit den besten systemen bis zur 15ten Gruppe gekommen."

† See quotations from a letter of Eulenstein in the paper of Mr. Charles Stodder hereafter quoted.

‡ Nobert's test-plate and modern microscopes, American Naturalist, vol. ii, p. 97, also Microscopical Journal, July, 1868, p. 131. To the latter article Mr. Stodder appends a note in which he claims that Dr. Barnard also has seen the real lines in the nineteenth band. I am quite sure the lines Dr. Barnard saw were also spurious ones, and he himself writes me that his opinions in the matter were not fully matured, and that he intends to make further observations.

teenth band by the very simple method I shall append, or to make a photograph of them, either of which will, I think, speedily bring them to my opinion.

I have lately made a careful study of a nineteen-band plate belonging to Rev. Dr. F. A. P. Barnard, which was made for him by Nobert during 1867.

To convince all microscopists interested of the accuracy of my statements, I have had photographs of the different bands made by Dr. E. Curtis, at the Army Medical Museum.

I am satisfied that I have seen, and that Dr. Curtis has photographed the true lines in the fifteenth band, but no further. Dr. Curtis has also photographed two views of the sixteenth, seventeenth, eighteenth and nineteenth bands, in which lines are clearly seen, which, however, I conclude from their number and character to be spurious, although both he and I supposed them to be real before counting them by the method I shall presently mention. For example, the spurious lines in the photograph of the seventeenth band are 30 in number in one photograph; 40 in another; the real number of lines according to Nobert's statement being 51.

I send herewith a full set of these photographs to the editors of this Journal.

In these photographs the lines count as follows in the several bands:

First,	7 lines.	Eighth,	25 lines.	Fifteenth,	45 lines.
Second,	10 "	Ninth,	27 "	Sixteenth,	not counted.
Third,	13 "	Tenth,	30 "	Seventeenth,	" "
Fourth,	15 "	Eleventh,	34 "	Eighteenth	" "
Fifth,	17 "	Twelfth,	37 "	Nineteenth,	" "
Sixth,	20 "	Thirteenth,	40 "		
Seventh,	23 "	Fourteenth,	43 "		

The photographs were taken with the $\frac{1}{25}$th of Powell and Lealand, and a distance sufficient to magnify 1000 diameters linear. The slide was illuminated by direct sunlight passed through a solution of sulphate of copper in ammonia, and concentrated by an achromatic condenser, with large diaphragm opening, without any central stop, the pencil made oblique by throwing the condenser to the right or left of its true centering. I tried on the slide many object glasses, including an $\frac{1}{8}$th of Ross, a $\frac{1}{10}$th of Tolles, a No. 11 immersion of Hartnack, an $\frac{1}{6}$th, $\frac{1}{15}$th and immersion $\frac{1}{16}$th by Wales, but got the best results with the $\frac{1}{25}$th. The $\frac{1}{30}$th of Powell and Lealand did not do quite so well as the $\frac{1}{25}$th, apparently on account of the thickness of cover.

Dr. Curtis has also made two photographs of the twelfth, thirteenth and fourteenth bands, in which the resolution being

imperfect, spurious lines are shown. The thirteenth band, for example, shows 25 lines in one photograph, and 16 in the other, the real number being 40.

These two photographs agree closely in character with those of the sixteenth, seventeenth, eighteenth and nineteenth bands.

The foregoing results lead me to believe that the lines in the last four bands are really ruled as claimed by Nobert; and that with greater defining power the true lines could be seen. They also compel me to doubt the accuracy of the statements of those who think they have seen the true lines in any band beyond the fifteenth, and especially if the lines seen have not been counted.

I may here mention that the first of this series of photographs represented the last four bands, and was made by Dr. Curtis some months ago. Both he and I supposed at the time that the lines shown on the sixteenth and seventeenth band in this photograph were real. We accounted for their being too few in number (those of the sixteenth counting 37, those of the seventeenth, 40 lines), by supposing that the whole of each band was not to be seen in any one position of the focal adjustment.

Subsequent experience has, however, convinced us that these also are spurious lines. I learn from Dr. Barnard that this photograph was sent by Eulenstein to Nobert, who accounted for the small number of lines by supposing Dr. Curtis had by mistake copied the twelfth, thirteenth, fourteenth and fifteenth bands! We had, however, made no such error, of which I doubt not Nobert will be convinced on receiving the present series of photographs, copies of which I have sent to him.

In conclusion, I may mention briefly two modes of conveniently counting the lines in the highest bands that can be resolved.

If a cobweb micrometer is used, the micrometer eye-piece should be firmly clamped in a stand screwed to the table, so that the eye-piece is close to the end of the microscope tube, but does not touch it, a piece of black velvet being used to complete the connection. The motion of the micrometer screw now communicates no tremor to the microscope, and all difficulty in counting the lines seen (whether real or spurious) disappears. Still better than this is the following method: The microscope being set up in a dark room as though to take a photograph, and the eye-piece being removed, the image of the band to be counted is received on a sheet of plate glass in the plate holder, and viewed with a focussing glass, on the field lens of which a black point is marked. As the focussing glass is moved on the plate from side to side, the black point is moved from line to line. The lines may thus be counted with as much ease and precision as if they were large enough to be touched by the finger.

ART. XXXV.—*Notes on the Geology of Southwestern Ontario;* by T. STERRY HUNT, F.R.S., of the Geological Survey of Canada.

(Read before the meeting of the American Association for the Advancement of Science, at Chicago, August, 1868.)

THE paleozoic strata of the southwestern portion of the province of Ontario (late Upper Canada), are generally covered by a considerable thickness of clay, which has made their study extremely difficult. During the last few years, however, numerous borings have been made over a wide area in this region, in search of petroleum, and have disclosed many facts of geological interest. By frequently visiting the localities, and carefully preserving the records of these borings, I have been enabled to arrive at some important conclusions as to the thickness and the distribution of the underlying Upper Silurian and Devonian strata, to which I now beg to call the attention of the Association.

The rocks of the New York series, from the Oriskany sandstone to the Coal, which are regarded as the equivalents of the Devonian of the old world, were shown by Prof. James Hall, in 1851, to constitute three natural groups. Of these, the first and lowest, sometimes called the Upper Helderberg, and consisting of the Oriskany, with its overlying Corniferous limestone (embracing the local subdivision known as the Onondaga limestone), constitutes what may be provisionally called the Lower Devonian. The second group has for its base the black pyroschists, known as the Marcellus shale, followed by the Hamilton shale, with the local Tully limestone, and terminated by another band of black pyroschist, the Genesee slate; the whole constituting what may be termed the Middle Devonian. The third group, embracing the Portage and the Chemung shales and sandstones, with the local Catskill sandstone, makes the Upper Devonian.*

The black Genesee slate, according to Mr. Hall, is paleontologically related to the Hamilton slates, and by him included as part of the Hamilton group, as recognized in *The Geology of Canada.* Similar black slates, though thicker, less fissile, and interstratified with greenish arenaceous beds, occur at the base of the Portage formation, marked by the remains of land plants and of fishes which characterize the Upper Devonian. The black slates at this horizon thus constitute, as it were, beds of passage. The thickness of the lower and more fissile black beds, recognized by Mr. Hall as belonging to the Hamilton group, is, according to him, only twenty-four feet at the eastern end of Lake Erie.

* James Hall, in Foster & Whitney's Geology of Lake Superior, ii, 386.

There exists in southwestern Ontario, along the River St. Clair, an area of several hundred square miles underlaid by black shales, in the counties of Lambton and Kent, of which only the lower part belongs to the Hamilton group. These strata are exposed in very few localities, but the lower beds are seen in Warwick, where they were, many years since, examined by Mr. Hall, in company with Mr. Alexander Murray of the Geological Survey of Canada, and were by the former identified with the Genesee slate forming the summit of the Hamilton group. They are in this place, however, overlaid by more arenaceous beds, in which Prof. Hall at the same time detected the fish remains of the Portage formation. The thickness of these black strata, as appears from a boring in the immediate vicinity, is fifty feet, beneath which are met the gray Hamilton shales. A similar section occurs at Cape Ipperwash or Kettle Point in Bosanquet, on Lake Huron, where bands of alternating greenish and black arenaceous shales, holding *Calamites*, are met with. These strata also were recognized by Mr. Hall, who examined them, as belonging to the Portage formation ; and abound in the large spherical calcareous concretions which occur at the same horizon in New York. The entire thickness of the black shales at this point has not been determined, but in numerous borings throughout the region under notice, they are easily distinguished, both by color and hardness, from the soft gray Hamilton shales which underlie them. At Corunna, near Sarnia, a thickness of not less than 213 feet of hard black shales, interstratified toward the top with greenish sandstone, were met with. In the northern part of Enniskillen, near Wyoming, they are about fifty feet in thickness; at Alvinstone, eighty feet ; in Sombra, on the Sydenham river, 100 feet, and in two borings in Camden, 146 and 200 feet. A little to the north of Bothwell, on the Thames, their thickness was found to be seventy-seven feet, while southward, along the shore of Lake Erie, about sixty feet of the hard black slate overlie the soft gray Hamilton shales.

From these, and a great many similar observations, which are detailed at length in the Report of the Geological Survey of Canada, published in 1866, it has been possible to determine with considerable accuracy the distribution of these black strata beneath the thick covering of clay which conceals them through the greater part of the region. It being impossible, under the circumstances, to distinguish between that lower portion of the black strata which belongs to the Hamilton group or Middle Devonian, and the overlying Portage formation, the whole of these strata, down to the summit of the soft gray shales, are included with the Portage. In Michigan, according to Prof. Winchell, the whole thickness of the Portage (Huron) group,

as just defined, including twenty feet of black shale at its base, is only 224 feet, which are represented in Ontario by 200 feet on the Sydenham river, and by 213 feet at Corunna on the St. Clair. Yet Prof. Winchell, for some reason, doubts the existence of the Portage formation in Ontario.

The Hamilton shale, which in some parts of New York attains a thickness of 1,000 feet, but is reduced to 200 feet in the western part of the state, consists in Ontario chiefly of soft gray marls, called soapstone by the well-borers, but includes at its base a few feet of black beds, probably representing the Marcellus shale. It contains, moreover, in some parts, beds of from two to five feet of solid gray limestone, holding silicified fossils, and in one instance impregnated with petroleum, characters which, but for the nature of the organic remains, and the underlying marls, would lead to the conclusion that the Lower Devonian had been reached. The thickness of the Hamilton shale varies in different parts of the region under consideration. From the record of numerous wells in the southeastern portion, it appears that the entire thickness of soft strata between the Corniferous limestone below and the black shale above, varies from 275 to 230 feet, while along the shore of Lake Erie it is not more than 200 feet. Further north, in Bosanquet, beneath the black shale, 350 feet of soft gray shale were traversed in boring, without reaching the hard rock beneath, while in the adjacent township of Warwick, in a similar boring, the underlying limestone was attained 396 feet from the base of the black shales. It thus appears that the Hamilton shale (including the insignificant representative of the Marcellus shale at its base) augments in volume, from 200 feet on Lake Erie to about 400 feet near to Lake Huron. Such a change in an essentially calcareous formation, is in accordance with the thickening of the Corniferous limestone in the same direction.

The Lower Devonian in Ontario is represented by the Corniferous limestone, for the so-called Onondaga limestone has not been recognized, and the Oriskany sandstone, always thin, is in some places entirely wanting. The thickness of the Corniferous in western New York is about ninety feet, and in southeastern Michigan is said to be not more than sixty, although it increases in going northward, and attains 275 feet at Mackinac. In the townships of Woodhouse and Townsend, about seventy miles west from Buffalo, its thickness has been found to be 160 feet, but, for a great portion of the region in Ontario underlaid by this formation, it is so much concealed that it is not easy to determine its thickness. In the numerous borings which have been sunk through this limestone, there is met with nothing distinctive to mark the separation between

it and the limestone beds which form the upper part of the Onondaga salt group or Salina formation of Dana, which consists of dolomites, alternating with beds of a pure limestone, like that of the Corniferous formation. The saliferous and gypsiferous magnesian marls, which form the lower part of the Salina formation are, however, at once recognized by the borers, and lead to important conclusions regarding this formation in Ontario. In Wayne county, New York, the Salina formation has a thickness of from 700 to 1000 feet, which, to the westward, is believed to be reduced to less than 300 feet, where the outcrop of this formation, crossing the Niagara river, enters Ontario.

At Tilsonburg, ninety miles west from Buffalo, borings have shown the existence of the Corniferous limestone directly beneath about forty feet of clay, while two miles to the southwest, it is overlaid by a few feet of soft shales, probably marking the base of the Hamilton. From a depth of 100 feet in the limestone, at Tilsonburg, a flowing well was obtained, yielding an abundance of water, and a considerable quantity of petroleum. This boring was subsequently carried 854 feet in the rock, which at that depth was a dolomite. Numerous specimens from the upper 196 feet were pure non-magnesian limestone; but below that depth dolomites, alternating with pure limestones, were met with to the depth of 854 feet, from which salt water was raised, marking, it is said, from 35° to 50° of the salometer. The well was then abandoned. We have here a boring traversing 854 feet of solid strata, from what was, probably, near the summit of the Corniferous, without reaching the marls which form the lower part of the Salina formation.

In a boring at London, where the presence of the base of the Hamilton was marked by about twenty feet of gray shales, including a band of black pyroschist, overlying the Corniferous, 600 feet of hard rock were passed through before reaching soft magnesian marls, which were penetrated to the depth of seventy-five feet. Specimens of the borings from this well, and from another near by, carried 300 feet from the top of the Corniferous, show that pure limestones are interstratified with the dolomites to a depth of 400 feet. At Tilsonburg a pure limestone was met with at 524 feet from the top.

At St. Mary's, 700 feet, and at Oil Springs in Enniskillen, 595 feet of limestone and dolomite were penetrated, without encountering shales, while in another well near the last, soft shaly strata were met with at about 600 feet from the top of the Corniferous limestone, there overlaid by the Hamilton shales. It thus appears that the united thickness of the Corniferous formation and the solid limestones which compose the

upper part of the Salina formation, is about 600 feet in London and Enniskillen, and farther eastward, in Tilsonburg and St. Marys, considerably greater, exceeding by an unknown amount, in these localities, 854 and 700 feet. The Corniferous at its outcrop in Woodhouse, twenty-five miles to the east of Tilsonburg, measures only 160 feet thick, so that there is evidently, in the localities just mentioned, a great increase in the volume of the Salina formation from the 300 feet observed in western New York. At Goderich, on Lake Huron, the thickness of this formation is much greater. Here are found non-fossiliferous strata, having the character of the so-called Water-lime beds, which belong to the summit of the Salina formation, and are immediately overlaid by fossiliferous strata belonging to the Corniferous formation. At this point a boring in search of petroleum penetrated not less than 775 feet of solid white, gray and blue limestones, chiefly magnesian, with occasional thin beds of sandstone. Below this depth the strata consisted chiefly of reddish and bluish shales, with interstratified beds of gypsum, sometimes ten feet in thickness. After the 164 feet of these, rock salt was met with, interstratified with clay, through a distance of forty-one feet, beneath which the boring was carried five feet in a solid white limestone, probably belonging to the underlying Guelph formation. We have thus, for the entire thickness of the Salina formation at Goderich, 980 feet, of which the upper 775 are hard strata, chiefly magnesian limestones, and 205 feet gypsiferous and saliferous shales. Several wells since sunk in this vicinity, one of them twelve miles to the southwestward, have given almost identical results, including the mass of rock salt at the base. These borings now yield, by pumping, a copious supply of brine, nearly saturated and of great purity, so that this newly discovered saliferous deposit has already attracted the attention of salt manufacturers, both in Ontario and New York. A detailed description of the first well, with an analysis of the brine, will be found in the Geological Report for 1866, already referred to.

Brines are said to have been met with at this horizon in Michigan, where the formation will probably be found to have a much greater thickness than that hitherto assigned to it.

It thus appears that the Salina formation, after being reduced to less than 300 feet at the Niagara river, again assumes, to the northwestward, a thickness of nearly 1,000 feet, and becomes once more salt-bearing, as in the State of New York. The increased thickness of the formation in these two regions, connected with accumulations of salt at its base, would seem to point to ancient basins, or geographical depressions in the

surface of the underlying formation, in which were deposited these thicker portions. The existence of these Upper Silurian salt lakes, whose evaporation gave rise to the rock-salt, gypsum and dolomite of the Salina formation, shows a climate of great dryness to have then prevailed in this region. A similar conclusion is to be drawn from the more or less gypsiferous dolomites of the Calciferous and Niagara formations, the magnesian limestones at other horizons, and the gypsum and salt deposits of the Carboniferous period,—leading us to infer a very limited rain-fall over the northeastern portion of this continent, throughout the Paleozoic period.

In this connection a few remarks with regard to the horizon of the petroleum which issues from the Devonian rocks of Ontario, may not be out of place. In opposition to the generally received view, which supposes the oil to originate from a slow destructive distillation of the black pyroschists belonging to the middle and upper divisions of the Devonian, I have maintained that it exists, *ready formed*, in the limestones below.* In addition to the well known fact of its frequent occurrence in the Corniferous limestone, I have cited the observations of Eaton, Hall and myself, as to the existence of both solid and liquid bitumen in the Niagara limestone, and even in the massive beds of the Hamilton. A remarkable example is afforded in the oleiferous beds of the Niagara formation in the vicinity of Chicago,† and still another in similar strata belonging to the Lower Helderberg period, in Gaspé. The deep borings already mentioned in Tilsonburg, St. Mary's and Enniskillen, showed in each case small quantities of petroleum in strata of the Salina formation, and the same was observed at considerable depths in the Goderich well already described.

Apart from the chemical objections to the view which supposes the oil to be derived from the pyroschists above the Corniferous limestone, it is to be remarked, that all the oil wells of Ontario have been sunk along denuded anticlinals, where, with the exception of the thin black band sometimes met with at the base of the Hamilton formation, these so-called bituminous shales are entirely wanting. The Hamilton formation, moreover, is never oleiferous, except in the case of the rare limestone beds already referred to, which are occasionally interstratified. Reservoirs of petroleum are met with, both in the overlying quaternary gravels and in the fissures and cavities of the Hamilton shales, but in some cases the borings are carried entirely through these strata, into the Corniferous limestone, before getting oil. Among other instances cited in my Geolo-

* Canadian Naturalist, June, 1861, and this Journal, March, 1863.

† It is proposed to give, in a subsequent communication, the results of an examination of this remarkable limestone.

gical Report for 1866, may be mentioned a well at Oil Springs, in Enniskillen, which was sunk to a depth of 456 feet from the surface, and seventy feet in the solid limestone beneath the Hamilton shales, before meeting oil, while in adjacent wells supplies of petroleum are generally met with at varying depths in the shales. In a well at Bothwell, oil was first met with at 420 feet from the surface, and 120 feet in the Corniferous limestone, while a boring at Thamesville was carried 332 feet, of which the last thirty-two feet were in the Corniferous limestone. This well yielded no oil, until, at a depth of sixteen feet in this rock, a fissure was encountered, from which, at the time of my visit, thirty barrels of petroleum had been extracted. At Chatham, in like manner, after sinking through 294 feet of shales, oil was met with at a depth of fifty-eight feet in the underlying Corniferous limestone.

We also find oil-producing wells sunk in districts where the Hamilton shale is entirely wanting, as in Maidstone, on the shore of Lake St. Clair, where, beneath 109 feet of clay, a boring was carried through 209 feet of limestone, of which the greater part consisted of the Water-lime beds of the Salina formation overlaid by a portion of the Corniferous. At a distance of six feet in the rock a fissure was struck, yielding several barrels of petroleum. Again at Tilsonburg, where the Corniferous limestone is covered only by quaternary clays, natural oil springs are frequent, and, by boring, fissures yielding petroleum were found at various depths in the limestone, down to 100 feet, at which point a flowing well was obtained, yielding an abundance of water, with some forty gallons of oil daily. The supplies of oil from wells in the Corniferous limestone are less abundant than those in the overlying shales, and even in the quaternary gravels, for the obvious reason that both of these offer conditions favorable to the retention and accumulation of the petroleum escaping from the limestones beneath.

The presence of petroleum in the Lower Silurian limestones, and their probable importance as sources of petroleum, was first pointed out by me in 1861. The conditions under which oil occurs in these limestones in Ontario, are worthy of notice, inasmuch as they present grave difficulties to those who maintain that petroleum has been generated by an unexplained process of distillation going on in some underlying hydrocarbonaceous rock. Numerous borings in search of oil on Manitoulin Island, have been carried down through the Utica and Loraine shales, but petroleum has been found only in fissures at considerable depths in the underlying limestones of the Trenton group. The supplies from this region have not hitherto been abundant, yet from one of the wells just mentioned, 120 bar-

rels of petroleum were obtained. The limestone here rests on the white unfossiliferous Chazy sandstone, beneath which are found only ancient crystalline rocks, so that it is difficult to avoid the conclusion that this limestone of the Trenton group is, like those of Upper Silurian and Devonian age already noticed, a true oil-bearing rock.

In concluding these observations on the geology of Ontario, it may be remarked that throughout the southwestern counties the distribution of the middle and upper Devonian rocks has been determined almost wholly from the results of borings undertaken in search of petroleum. From these it appears that the wide spread of these rocks in this region is connected, first, with a tranverse north and south synclinal depression, which traverses the peninsula, and has been noticed in the *Geology of Canada*, p. 363, and secondly, with several small undulations, running northeast and southwest, on the northwest side of the anticlinal of the Thames; which is a prolongation of that passing by Cincinnati, and may be regarded as part of the main anticlinal of the great axis of elevation which divides the coal field of Pennsylvania from that of Michigan.

The Devonian rocks are found in the region under consideration, at depths not only far beneath the water-level of the adjacent lakes of Erie and St. Clair, but actually below the horizon of the bottom of those shallow lakes. Thus at Vienna, in Bayham, at a point said to be about forty feet above the level of Lake Erie, the underlying rock was met with beneath 240 feet of clay, while at Port Stanley, twenty feet above the lake, the Hamilton shale was struck beneath 172 feet of clay, and at the Rondeau, just above the level of Lake Erie, the clay was 104 feet thick. A similar condition of things exists on the south side of the lake, at Cleveland, where no rock is encountered at a depth of 100 feet below the water-level. Again in Sombra, on the banks of the Sydenham river, which is a very little above the level of Lake St. Clair, a well ten feet above the river passed through 100 feet of clay before meeting the black shales of the Portage group, while in Maidstone, on the shore of Lake St. Clair, and a very few feet above its level, 109 feet of clay were found overlying the Corniferous limestone. The greatest depth of Lake St. Clair is scarcely thirty feet, and that of the southwestern half of Lake Erie does not exceed sixty or seventy feet, so that it would seem that these present lake basins have been excavated from the quaternary clays which, in this region, fill a great ancient basin, hollowed out of the paleozoic rocks, and including in its area the southwestern part of the peninsula of Ontario.

ART. XXXVI.—*On the action of Sunlight on Bisulphid of Carbon;* by O. LOEW, Chemical assistant in the College of the City of New York.

PURE bisulphid of carbon, when exposed to the sunlight for a considerable time becomes somewhat yellow. To study the changes thus produced, a large quantity of the bisulphid was enclosed in sealed tubes and exposed to the action of the sun. Decomposition took place gradually, and a brown insoluble substance was formed, which adhered so closely to the inner surface of the tubes that it could not be detached by vigorous shaking. This substance prevented the farther action of the sun's rays, and consequently the decomposition ceased.

If water be present in the tubes, this adherence is prevented and a larger quantity of the brown substance is obtained. After an exposure of two or three months the tubes were opened. The water was slightly acid in its reaction, and, after being neutralized and concentrated, it showed a distinct reducing power upon salts of silver and mercury. Evidently therefore a trace of formic acid was produced, according to the following equation:

$$CS_2+2H_2O=\overset{\text{Formic Acid.}}{CH_2O_2}+H_2S+S.*$$

On filtration, the newly formed brown compound remained on the filter, while the filtrate contained free sulphur dissolved in the bisulphid of carbon. On examination, this compound corresponded in every particular to the *sesquisulphid of carbon*, the substance discovered by me two years ago. It was insoluble in water, alcohol, ether, chloroform, bisulphid of carbon, and oils, but soluble with decomposition in a boiling solution of caustic potassa. On heating it in a glass tube, it was directly separated into its components; the sulphur volatilized and the carbon remained.

If sulpho-carbonate of potassa, in concentrated solution, be exposed to the sunlight, the decomposition is so slight as hardly to be noticed; when the solution is treated with sodium amalgam, however, a reduction to lower sulphids takes place.

In view of the fact that direct sunlight reduces free bisulphid of carbon, it might be supposed that the corresponding body, carbonic acid, would, in presence of water, be reduced in a similar manner; all my experiments in this direction, however, have thus far been unsuccessful. Nevertheless, since this reduction takes place very readily in the tissues of plants under the influence of sunlight, I am not without hope that this process will yet be imitated in the laboratory.

New York, Sept. 20, 1868.

* C=12; O=16; S=32, etc.

ART. XXXVII.—*Observations on the Metamorphosis of Siredon into Amblystoma;* by O. C. MARSH, Professor of Palæontology in Yale College. With a plate.

WHILE on a geological excursion to the Rocky Mountains, during the past summer vacation, the writer obtained at Lake Como, in Wyoming Territory, a number of specimens of *Siredon lichenoides* Baird, one of the most interesting forms of the *Urodela*, or tailed Batrachians, and one hitherto but little studied. This lake is a small shallow sheet of water, distinctly brackish, or "alkaline," apparently from the salts of soda. It lies near the Union Pacific Railroad, about 640 miles west of Omaha, and at an elevation of about 7,000 feet above the sea. The surrounding region is an arid desert, with little or no vegetation except cactus and wild sage.

The Siredons obtained at this locality, where the species, known as the "Fish with legs," is quite abundant, showed at first no differences except those of age and sex. They were from five to ten inches in length, of a uniform dark olive, or pistachio-green color above, and a light olive below. The vascular fimbriæ of the external branchial appendages, or gills, were black. In form and general appearance all the specimens corresponded essentially with the one represented in figures 1 and 1*a*, in the accompanying plate. They were brought to New Haven alive, apparently without suffering much inconvenience, either from a transfer to fresh water, or from the long journey. They all fed readily upon worms and insects, and occasionally came to the surface and inhaled air. More rarely an exhalation occurred, usually under water. On being removed from their native element they soon showed the same signs of distress as fishes under similar circumstances, although in a much less degree.

The account recently published by Prof. Duméril of the remarkable metamorphosis of the second generation of Axolotls (*Siredon Mexicanus*) from the table lands of Mexico, while kept in the Muséum d'Histoire naturelle, in Paris,* made it a point of no little interest to determine whether this species also would undergo a similar change when placed under different physical conditions, and hence the specimens were watched with considerable care.

The first indications of any change were observed in one of the smaller specimens, about six inches in length; and the metamorphosis had apparently commenced during the journey from Lake Como to New Haven, which lasted about a week. Small round spots of dark brown were first noticed on the sides

* Comptes Rendus, tome lxi, p. 775, 1865, and tome lxv, p. 242, 1867.

of the tail, and the color of the entire animal gradually assumed a darker hue. The broad thin membrane along the back, and above and below the tail, gradually began to diminish by absorption, the external branchial appendages soon became similarly affected, especially at the ends, and the animal came more frequently to the surface of the water for air. As the change went on, the dark spots increased in number and size, and gradually extended over the whole upper part of the body. The membrane on the back and tail entirely disappeared, leaving in its place in the dorsal region a sharp groove. The branchiæ also continued to diminish, and at the same time the internal branchial arches began to be absorbed, and shortly after the openings on the neck closed up. In the meantime the head became more rounded above, and more oval in outline, the muzzle narrower and more pointed, and the eyes more convex and prominent. The body also decreased in bulk, and the costal grooves became more distinct. The thin external skin was shed, and the secretion of mucus from the surface sensibly diminished. During these changes the animal showed an increasing desire to leave the water, often remaining for some time with its external nostrils above the surface, and occasionally making violent struggles to escape. Aided by a heavy rain at night it at last succeeded, and thus put an end to further observations, just at a time when it had lost the generic characters of *Siredon*, and become a true *Amblystoma*, two forms of Batrachians usually regarded hitherto as belonging to distinct families.

Fortunately, a few days later, several other specimens of various sizes began, nearly at the same time, to show unmistakable indications of a similar transformation, and this afforded an opportunity of noting the successive phases of the change more fully, as well as of observing the physical conditions which seemed to promote or retard it. Two of the specimens were placed in a glass jar, and left in a strong light, and five others were kept in a cooler place in the shade, the temperature of the two, however, differing but a few degrees. At the end of three weeks those in the glass vessel had apparently completed their metamorphosis, while of the others less favorably situated three only were partially altered, and at the present time, or nearly three weeks later, they still retain tubercular remnants of the external branchiæ, although in most other respects the change appears to be complete. The two remaining specimens, however, which had throughout been kept with the three last, showed no distinct signs of changing, although the probability of their doing so, and the importance of retaining some tangible evidence of the original condition, led to the transfer of one

of them to a jar of alcohol after the first week, a precaution, as the result showed, quite unnecessary in the case of the other, which at the time of writing (Oct. 5th) still remains a typical Siredon, with no alteration more important than a single appearance in a new epidermis.

The changes observed in the five specimens that underwent the complete metamorphosis were essentially the same as those noticed in the one already described, although in no two individuals were the successive phases quite contemporaneous or identical. The most marked differences observed were in the color, both during the transformation, and after its completion. This was very noticeable even in specimens exposed to the same physical conditions. In the siredon state all were apparently precisely alike in this respect, and the first indications of change detected in each case was the appearance of the small dark spots along the sides of the tail. From this stage onward the variation in color in different individuals became very marked. Of the two specimens exposed to a strong light in the glass vessel, one rapidly became covered with dark spots, especially on the back and sides, until finally these predominated, and the grayish yellow of the ground color only remained in vertical and irregular patches (figure 3), the rest being a greenish black. The companion of this specimen, however, although apparently equally advanced in development, retained for some time nearly the original siredon color, the only difference being some irregular blotches on the sides, to which the specific name *lichenoides* would very appropriately apply. These were the extremes of coloring after the change, the other specimens showing various intermediate grades, one individual, represented in fig. 2, having dark brown spots on a light olive ground. All the altered specimens, it should be stated, apparently belonged to the species *Amblystoma mavortium* Baird, as recently defined by Prof. Cope in his able Review of the Amblystomidæ ;* and it is an interesting fact that among the six specimens that have already changed, the present coloration appears to indicate two, if not three, of the forms which he there regards as varieties, although previously considered as species by other eminent authorities. The two types best represented are shown in figures 2 and 3. In this connection should perhaps be mentioned a remarkable change of color which took place in one of the Siredons before any indications of metamorphosis had been detected. The animal had been in the dark for several days, and was then placed in a white porcelain vessel, and kept for several hours in a strong light, while an attempt was made to

* Proceedings Philadelphia Acad., xlx, p. 166, 1867.

photograph it. During this time it changed from the dark siredon color to a very light yellow. The next morning the original color had returned, but a second exposure produced the same change, which was as speedily reversed on returning the animal to the dark, although it evidently suffered considerably from the treatment. Even a moderately strong light appeared to be distasteful to all the Siredons, and they usually sought the darkest part of the space in which they were confined.

The second distinct phase in the metamorphosis, which, however, commenced in every instance before the change in color had made much progress, was the absorption of the dorsal and caudal membranes. This began on the lower margin of the tail, and soon after could be detected in the dorsal region, and then farther back, the last portion remaining being usually on the upper part of the tail. The absorption extended below the dorsal surface, leaving at first a groove along the back, marking the position of the membrane; and as this disappeared the light colored specimens retained in its place a narrow black line, which extended also to the end of the tail.

The absorption of the external branchiæ was the next marked feature in the transformation, although this also commenced before the changes just mentioned were completed. The atrophy apparently began at the extremities of the branchial processes, and when these had diminished to about half their natural size, and the fimbriæ had disappeared, the ends rolled up underneath, leaving the remnants as rounded tubercles, which, in some of the specimens remained long after all the other stages of the transformation were passed (figure 2). The absorption, moreover, did not always proceed with equal rapidity on the two sides of the same animal, but in one instance stumps of the processes were retained on one side some time after those on the other had disappeared. During the diminution of the external branchiæ, the internal vascular arches which support the external processes also became absorbed. As these disappeared, the orifices on either side of the neck, and the open fold of the throat became closed by the adhesion of the opercular flap to the surface below, leaving, especially in the gular region, a deep cicatrix. These changes, which were in each case apparently completed before the remnants of the externa branchiæ had disappeared, were evidently the main cause of a marked alteration in the shape of the head, which occurred about the same time. In the siredon state the head is broadest at the base, and comparatively flat above (figures 1 and 1 *a*), but after the loss of the branchial arches, its greatest breadth was a little back of the eyes, while it was much more rounded

above, and in outline more oval. The neck also diminished in size, and the snout became more pointed. The change in the eyes, already alluded to, likewise altered the appearance of the head materially. The flat, fish-like eye of the Siredon projected very slightly above the surface of the head, but during the transformation this organ became more convex, and also much more prominent (figures 2 and 3). This change in the eye was apparently indicated also in the habits of the animal. The Siredons seldom missed their aim in catching a worm or insect, but when under water after the metamorphosis they often made several ineffectual attempts to seize objects quite near them.

One of the most interesting features of the transformation occurred in connection with the mouth of the animal. The opening, or gape, increased considerably in size, one half at least; the internal and external nostrils became perceptibly more distended, and the tongue, which was at first small, enlarged so as nearly to cover the entire floor of the mouth. An important change also took place in the teeth. In the Siredon the palatine series on the vomerine and pterygoid bones formed an arch nearly concentric with the maxillary row, and extending forward between and beyond the inner nostrils. The arch is interrupted in front, and to some extent on the sides, as represented in figure 1*b*, which shows the position of these teeth, but not their exact number or size. After the metamorphosis, the palatine series project farther from the roof of the mouth, and become much more tranverse, forming an obtuse angle instead of an arch, with the interspaces nearly or quite united (figure 3*a*). The maxillary series also form a somewhat narrower arch, corresponding to the more pointed snout of the Amblystoma, and the splenial teeth of the lower jaw have gradually disappeared. These changes in the dental series, it should be stated, were not in all cases perfectly uniform in different individuals that had apparently passed through the same external phases of transformation, although the tendency was all in the same direction; and hence it is not unlikely that the palatine teeth of some, at least, of the specimens examined, may eventually become still more transverse than those represented in the figure.

Among the other more important changes which occurred during the metamorphosis may be mentioned the decrease in the size of the entire body, which was very marked, a perceptible increase in the distinctness of the costal grooves corresponding to the vertebræ, and the gradual ossification of the carpus and tarsus. The feet also became less palmate, and the toes less depressed. During the transformation, moreover, and espe-

cially after its completion, all the specimens shed the thin, transparent epidermis, some of them very frequently; one, indeed (figure 3), which had been kept in a strong light, lost this covering three times in the ten days immediately following the metamorphosis.

The change in the habits of the Siredon in passing into the Amblystoma state, was scarcely less marked than the alteration in its physical characters. As soon as the absorption of the external branchiæ commenced, the animal came more frequently to the top of the water and took in a mouthful of air; and not long afterwards would occasionally float for some time at an angle of about 45°, with the external nostrils above the surface. Frequent efforts to leave the water soon followed, and an opportunity of so doing was in most instances speedily improved, and the change then seemed to progress more rapidly. One or two specimens, however, showed for some time, especially in cool weather, much less inclination to desert their native element, apparently suffering little or no inconvenience from remaining under water, if allowed to come to the surface about once in five minutes. The pugnacious propensities of the Siredons, which at first led to occasional assaults on one another, appeared to diminish as the change progressed, and the more sluggish nature of Salamanders at last predominated; although the altered forms at times showed no little celerity of movement, and when irritated, especially when held by the tail, would often turn and snap at the hand with a rapidity that would have done no discredit to a reptile of much higher organization.

The effect on the metamorphosis of a variation in light and temperature has already been alluded to. During a succession of very warm days, about the first of September, the change progressed with great rapidity, but it apparently ceased, or made very slight progress, in the cool week that followed. While, moreover, the two specimens most favored in regard to light and warmth passed apparently through the entire transformation in about twenty days, those which commenced at the same time, but were less favorably situated, required at least twice that time for its completion. The only living specimen still remaining unchanged (figures 1 and 1*a*) has twice shown slight indications of an approaching metamorphosis, but with the exception of some spots, these have apparently soon disappeared after a transfer to a dark and cooler place.

Inasmuch as this species of *Amblystoma* appears to have never before been studied from living specimens, and especially as its larva (hitherto known only as *Siredon lichenoides* Baird)

has but very rarely been met with, it may be well to mention some of the more important characters noticed in the individuals just described, in addition to those given in the original description of the two forms, when the connection between them was unknown. It should, perhaps, be first stated that, after the observations here recorded, it becomes at once evident on examining Prof. Baird's excellent description and figures of *Siredon lichenoides*,* that the specimen on which the species was founded cannot be regarded as a typical larva, as it had already made considerable progress in its metamorphosis. This appears to be distinctly shown in the color markings, which suggested the specific name, and likewise in the dorsal and caudal membranes, which have apparently been materially diminished by absorption. The evidence of partial transformation seems to be equally strong, also, in the case of the specimen from Nebraska, subsequently figured and described by Prof. Baird under the name *Siredon melanosticta*, which is possibly only a variety of *S. lichenoides*.† The coloration, the irregular outline of the membranes, the rounded extremities of the branchial processes, as well as the arrangement of the palatine teeth, all indicate that the animal figured had already entered upon the preliminary stages of metamorphosis. In each of these cases, however, it is not improbable that the alteration may have been temporarily, or possibly even permanently, suspended, before the animal was captured. Aside from the features which may be the result of partial transformation, the Siredons from Lake Como do not differ essentially from Prof. Baird's original figures of *S. lichenoides*, except in having a somewhat broader head, and in not having the dorsal membrane extend to the occiput, differences which may be due merely to locality, as the type specimen came from a point about 400 miles farther south.

The Siredons obtained at Lake Como, as already stated, were from five to ten inches in length. The color of the body is a very dark olive above, and a light olive below, while the fimbriæ of the external branchiæ are nearly or quite black. On either side of the body are twelve costal grooves, not including the inguinal. The skin is smooth and transparent, and shows beneath it the ends of innumerable glands, thickly crowded together. In specimens preserved in alcohol these glands project, making the surface appear granular. The dorsal membrane commences a short distance from the base of the head, and both this and the lower membrane extend

* Stanbury's Exped. to the Great Salt Lake, p. 336, 1855.

† Pacific Railroad Report, vol. x, plate xliv, figure 1, and vol. xii, part 2, p. 306.

a little beyond the end of the tail, thus making the extremity slightly emarginate. The carpus and tarsus are unossified. The digits are broad at the base, depressed and triangular. The fourth toe is longest, and has four phalanges.

The head is broad and flat, and the muzzle rounded. The external nostrils are smaller, and slightly nearer together than the interior nasal openings. The eyes are round, and the iris of a yellowish metallic luster. A series of mucus-pores begins near the inner margin of each of the external nostrils, and diverging slightly extends over the nasal and frontal regions. Opposite the eyes they each connect with an orbital series, as shown in figures 1 and 1*a*. Another series, less distinct, exists on either side of the throat, just below the ramus of the lower jaw. Of the four branchial arches, only the three anterior support external processes, and the latter are thickly studded on their lower surfaces with lamellar fimbriæ. The maxillary and palatine series of teeth have already been mentioned, and their position in this species of Siredon is represented in figure 1*b*. The former consists of a single row of slender pointed teeth on the premaxillary and maxillary bones. The palatine arch of teeth, situated on the vomerine and pterygoid bones, forms a narrow and more complex series, only the position of which is given in the plate. The teeth of the lower jaw consist of a single row on the premandibular bones, and an adjoining and somewhat more complex series on the splenial bone. The two close in between the maxillary and palatine arches when the mouth is shut.

The following measurements are taken from two of the Lake Como Siredons. No. 1 is the individual figured in the accompanying plate, and No. 2 a specimen preserved a short time in alcohol.

MEASUREMENTS.

	No. 1.		No. 2.	
	Inches.	Lines.	Inches.	Lines.
Length from snout to end of tail,	7	9	8	
" " " " gular fold,	1	1	1	1
" " " " armpit,	1	8	1	9
" " " " groin,	3	9	3	10
" " " " behind anus,	4	4	4	5
Width of head where greatest,	1	3	1	4
" " tongue,	--	--		8
Distance between eyes anteriorly,		7		7
" " outer nostrils,		5		5
" " inner "	--	--		6
Length of anterior branchial process,		8		7
" " posterior " "	1	2	1	2
Distance between outstretched toes,	3	9	3	8
Height of tail including membranes where greatest,	1	3	1	3

Before the transformation was entirely completed, the generic characters of *Amblystoma* had become unmistakable; although

in each instance—as not unfrequently occurs in nature—some of the characters which distinguish the species had already preceded them. Among the altered forms, developed from larvæ apparently identical, the two types of coloration, shown respectively in figures 3 and 2, have each at present two representatives, and are sufficiently distinct to merit a more particular description. The former has a ground color of greenish black, on which are bands or patches of grayish yellow, more or less confluent, especially along the back. The abdomen is dusky olive, with a darker medial band. The latter type (figure 2) clearly corresponds to *Amblystoma maculatum* Hallowell, which is regarded by Prof. Cope as a variety of *A. mavortium* Baird. In this form the ground color is light olive, on which are scattered numerous small brown spots. In each specimen, a few of these first appeared on the tail, and next four of larger size on either shoulder, and subsequently others on the sides. The specimens of this type are also larger, and more sluggish in habit than the other variety, and until very recently would have been considered distinct species by all herpetologists. In most other respects, however, there is little or no difference between the two forms, and both of them, with one other specimen representing an intermediate grade, must apparently all be regarded as belonging to Prof. Baird's species *Amblystoma mavortium*.*

At the time the Siredons here described were obtained at Lake Como, several others also were secured by Prof. Eustis of Harvard College. All were brought to New York together, and there separated, part being taken to Cambridge, where they have since been carefully observed by Professors Wyman and Eustis, and the rest brought to New Haven by the writer. The former specimens, however, strange to say, have shown but very little inclination to change, none having commenced so doing until after several of the latter had fully developed into Amblystomata, and only the smallest, about five inches in length, having just completed its metamorphosis. This individual, as Prof. Wyman informs the writer, seems still to prefer remaining in the water—doubtless owing in part to the cool autumnal weather—although it is there exposed to attacks from the large Siredons, one of which has twice attempted to swallow it—an interesting fact illustrating the habits of the species. Two of the Siredons kept by Prof. Eustis escaped during a rain storm, and six days afterward one of them was found still alive, although shrivelled up, and the branchiæ partially gone. On being placed in water, it refused food, and soon died. That Siredons of apparently this species are occasionally found in wet grass near the

* Journal Acad. Nat. Sci. Philadelphia, 1849, p. 292.

water, especially after thunder showers, had already been noticed by Dr. Suckley,* but that they can remain out of water for several days is a new and important fact, showing that even before metamorphosis the lungs are sufficiently developed to sustain life without the aid of branchial or dermal respiration.

Whether this species of Siredon ever changes at Lake Como, and in other similar regions, is an interesting question, and one that cannot, perhaps, at present, be answered with certainty. That it does so occasionally, however, under favorable circumstances, especially when young, several facts known to the writer would seem to indicate, although Dr. Suckley, one of the few observers who have hitherto examined it in its habitat, regards it as probably permanently aquatic.† In the elevated region where Lake Como is situated, although the weather in summer is quite warm, the nights are always cool, and the changes of temperature often sudden and very great; hence the metamorphosis, if it began, would probably proceed slowly, and be liable to suspensions during its various stages. That the species, however, breeds in the siredon state, like the Mexican Axolotl, there can be little doubt, although direct evidence on this point appears to be wanting. The observations of Duméril, already alluded to, and other similar facts, render it probable that after reproduction the power of complete development would be lost; although alterations in color and other minor changes might still occur.

The near approximation in many Batrachians of the periods of reproduction and metamorphosis, and the effects, especially upon the later, of even slight differences of physical conditions, as shown in the preceding instances, are known to produce when combined remarkable variations in the same species, as well as other results until recently quite unexpected. The bearing of these and similar facts on a theory of development, although an inviting topic to enter upon, cannot for various reasons be discussed in this connection, but it is evident that in this direction lies a rich field for further investigation. The observations here recorded, however, when taken in connection with those of Duméril on the Mexican Axolotl, render it extremely probable—as Cuvier long ago seems to have suspected‡—that all Siredons are merely larval Salamanders, and also suggests a doubt whether some, at least, of the other so-called Perennibranchiates (by no means a natural division of the *Batrachia*) may not prove eventually to be the undeveloped young of well known species.

In addition to the acknowledgments already made, the writer

* Pacific R. R. Report, vol. xii, part 2, p. 306. † Loc. cit.

‡ Recherches anat. sur les Reptiles, etc., Paris, 1807, p. 35.

desires, in concluding, to express his thanks to Gen. W. Snyder, Superintendent of the Union Pacific Railroad, for his kind assistance in securing the Siredons at Lake Como in August last; to his friend Prof. E. D. Cope, of Philadelphia, for various suggestions in regard to the subject here treated of, and likewise to his friend, Prof. George F. Barker, of Yale College, for careful observations on the specimens while he was temporarily absent from New Haven.

Yale College, Oct. 10th, 1868.

EXPLANATION OF THE PLATE.

Figure 1. Undeveloped larva of *Amblystoma mavortium* Baird, hitherto known as *Siredon lichenoides* Baird. Animal represented as in motion, with external branchiæ thrown back (½ natural size).

Figure 1*a*. Dorsal view of same specimen when at rest, with branchiæ fully expanded (½ natural size).

Figure 1*b*. View from below, showing arrangement of maxillary and palatine series of larval teeth and inner nostrils of same species (natural size).

Figure 2. *Amblystoma mavortium* Baird, (variety *A. maculatum* Hall), partially developed from *Siredon lichenoides* Baird, with remnants of external branchiæ, and internal arches, still retained (½ natural size).

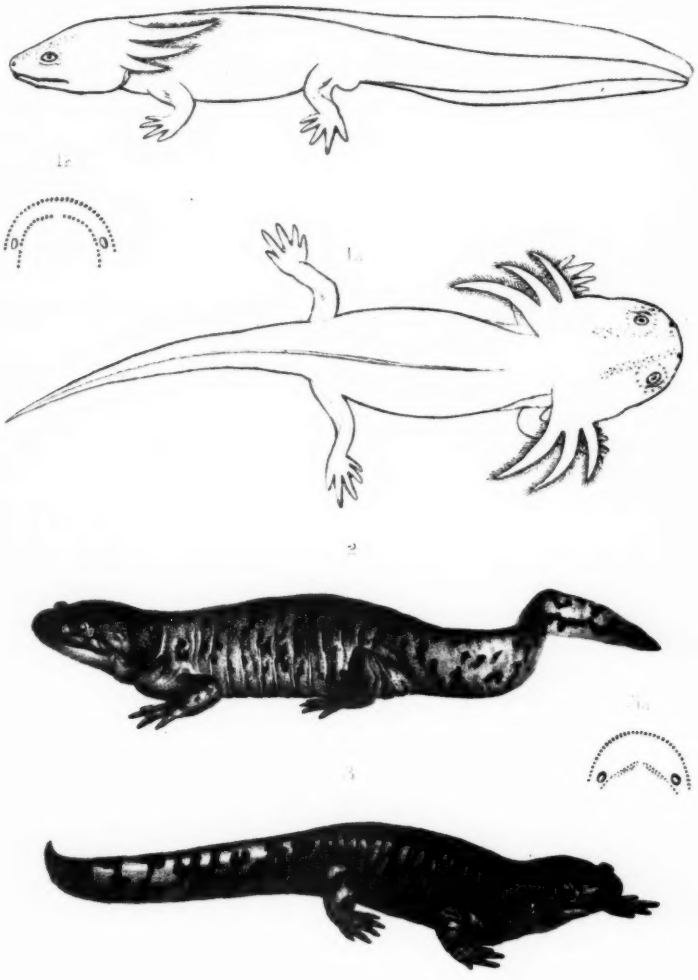
Figure 3. *Amblystoma mavortium* Baird, developed from *Siredon lichenoides* Baird: metamorphosis apparently completed (½ natural size).

Figure 3*a*. Maxillary and palatine series of teeth of *Amblystoma mavortium* Baird, after metamorphosis (natural size).

ART. XXXVIII.—*Notice of a new and diminutive species of fossil Horse* (*Equus parvulus*), *from the Tertiary of Nebraska*; by Prof. O. C. MARSH, of Yale College.

IN a small collection of fossil vertebrate remains, obtained by the writer during the past summer in the Tertiary deposits of Nebraska, there are several specimens of no little interest, as they indicate a new species of fossil horse, very much smaller than any hitherto known. These remains were collected at Antelope station on the Union Pacific Railroad, about 450 miles west of Omaha, where a few weeks before, during the excavation of a well, they had been thrown out from a depth of sixty-eight feet. This locality has since attained considerable notoriety, from the fact that the remains then found were pronounced to be human by those who first examined them, and various accounts of the discovery have been published in the newspapers. This, in fact, induced the writer, when in the vicinity, to examine the locality and its fossils, an account of which he has already given elsewhere.*

* National Academy of Sciences. Northampton Meeting, Aug. 1868.



The equine remains now to be noticed consist mainly of bones of the limbs, and among them is a hoof-phalanx, a coronary or second phalanx, parts of the first phalanx and metacarpals, as well as some of the smaller carpal and tarsal bones, and fragments, apparently from other parts of the skeleton. All are in an excellent state of preservation, and part of them are so characteristic that they clearly indicate the near affinities of the animal to which they belonged.

The ungual or hoof-phalanx differs in form from that of the recent horse only in being somewhat more depressed, and in having the sides of the upper surface slightly less convex transversely, and the beak of the articular face a little less pointed. Its length measured along the axis is very nearly one inch, the shorter diameter of the articular face is five lines, and the longer, or transverse, ten lines. The coronary, or middle phalanx, is proportionally more elongated than in the living species, and its proximal end rather more triangular. Its length along the axis in front is nine lines, the width of the articular face of the proximal end ten lines, and that of the distal end nine lines. The dimensions of all, or nearly all, of the remaining bones render it very probable that they belonged to the same individual, or at least to one of similar size, and specifically identical. They indicate an equine animal scarcely more than two feet, or possibly two and one-half feet in height, although full grown, as the ossification of the various bones clearly proves. Additional parts of the skeleton, especially the teeth, would perhaps show generic characters different from those of the living horse, but in the absence of these, as the remains are evidently distinct from any hitherto described, the species may be named *Equus parvulus*. This makes seventeen species of fossil horses now known to have lived in North America, although until quite recently it was very generally believed that there was none indigenous to the continent.

The bones above described occur in a stratum of gray arenaceous clay, lying nearly horizontally, and apparently of later Tertiary age. The large number of vertebrate remains found together in the space of a few feet indicates a remarkable locality, which unfortunately cannot again be reached except by deep excavation; and hence it is greatly to be regretted that so many of the specimens should have been lost to science by being carried away as human relics. Among those secured by the writer, in addition to the equine fossils, were the remains of several species of ruminants, a phalanx of a carnivorous animal about the size of a lynx, and fragments of a land turtle resembling somewhat the *Testudo neobrarensis* Leidy, all of which will be more fully described in this Journal at an early day.

Yale College, Oct. 5th, 1868.

Art. XXXIX.—*On Hansen's Theory of the physical Constitution of the Moon;* by Simon Newcomb.

The great reputation of the author has given extensive currency to the hypothesis put forth by Prof. Hansen some years since, that the center of gravity of the moon is considerably farther removed from us than the center of figure. The consequences of this hypothesis are developed in an elaborate mathematical memoir to be found in the twenty-fourth volume of the Memoirs of the Royal Astronomical Society. But the reception of the doctrine seems to have been based rather on faith in its author, than on any critical examination of its logical foundation.* Such an examination it is proposed to give it. An indispensable preliminary to this examination is a clear understanding of what the basis of the doctrine is. Let us then consider these three propositions:

1. The moon revolves on her axis with a uniform motion equal to her mean motion around the earth.

2. Her motion around the earth is not uniform, but she is sometimes ahead of and sometimes behind her mean place, owing both to the elliptic inequality of her motions and to perturbations.

3. Suppose her center of gravity to be farther removed from us than her center of figure, and so placed that when the moon is in her mean position in her orbit, the line joining these centers passes through the center of the earth.

Let us also conceive that these two centers are visible to an observer on the earth. Then a consideration of the geometrical arrangements of the problem will make it clear that when the moon is ahead of her mean place, the observer will see the two centers separated, the one nearest him being farther advanced in the orbit, while, when the moon is behind her mean place, the nearest center will be behind the other. This apparent oscillation of the two centers is, indeed, an immediate effect of the moon's libration in longitude.

Now the inequalities in the moon's motion, computed from the theory of gravitation, are those of a supposed center of gravity. But the inequalities given by observation are those of the center of figure. Hence, in the case supposed, the inequalities of observation will be greater than those of theory.

* In this connection it is curious to notice that on page 83 of his memoir Hansen appears as the first of the independent modern discoverers of Cagnoli's theorem of spherical trigonometry:

$$\cos a \cos b \cos C + \sin a \sin b = \cos A \cos B \cos c + \sin A \sin B.$$

This was about three years before the above formula was published as new by Mr. Cayley, and geometrically demonstrated by Prof. Airy in the Philosophical Magazine.

Also, their ratio will be inversely as that of the distances of the centers which they represent.

Prof. Hansen, in comparing his theory with observations, found that the theoretical inequalities would agree better with observation when multiplied by the constant factor 1·0001544. Supposing that this result could be accounted for on the hypothesis of a separation of the centers of gravity and figure, he thence inferred that the hypothesis was true. But the result cannot be entirely accounted for in this way, because the largest inequality of theory (evection) has a factor (eccentricity) which can only be determined from observation, and therefore even the theoretical evection is that of the center of figure, and not of the center of gravity. It must not be forgotten that the eccentricity, which is not given by theory, is subject to be multiplied by the same factor that multiplies the other inequalities. To be more explicit,

Let e be the true eccentricity of the orbit described by the moon's center of gravity. Then the true evection in the same orbit will be $e \times A$;

A being a factor depending principally on the mean motions of the sun and moon. And on Hansen's hypothesis, the *apparent* evection, or that of the center of figure, will be

$$e \times A \times 1{\cdot}0001544.$$

On the same hypothesis, the eccentricity derived from observation, being half the coëfficient of the principal term of the equation of the center, will be

$$e \times 1{\cdot}0001544,$$

and the theoretical evection computed with this eccentricity will be $e \times 1{\cdot}0001544 \times A$,

which is the same with that derived from observation. Hence,

The theoretical evection will agree with that of observation, notwithstanding a separation of the centers of gravity and figure of the moon.

That Hansen overlooked this point is to be attributed to his method of determining the lunar perturbations, by numerical computation from the various elements of the moon's motion, so that the manner in which the inequality depends on the elements does not appear. It is only when we determine the perturbations in algebraic form that this dependence appears.

Passing, now, from the evection, the next great perturbation of the moon's motion is the variation. But the value of this perturbation has not been accurately determined from observation, because, attaining its maxima and minima in the moon's octants, it is complicated with the moon's semi-diameter and parallactic inequality. Even if the semi-diameter is known, the two inequalities in question cannot be determined sepa-

rately with precision, because their coëfficients have the same sign in that part of the moon's orbit where nearly all the meridian observations are made. From this cause Airy's value of the parallactical inequality from all the Greenwich observations from 1750 to 1830 was 3″ in error. And when, in his last investigation,* Airy rejected the observations previous to 1811, owing to some uncertainty as to what semi-diameter should be employed, the result was still a second too small. It is therefore interesting to find what value of the variation will result if we substitute the known value of the parallactic inequality in Airy's equations for the determination of that element. Neglecting those unknowns which have small coëfficients, these equations are, from 1806 to 1851,

1806—15	10·66W +	28·14V =	+ 17·2
16—24	9·45 +	30·92	+ 24·9
25—33	9·43 +	29·26	+ 42·1
34—42	9·29 +	27·28	+ 10·8
43—51	9·05 +	23·36	+ 7·9
Sum,	47·88W +	138·96V =	+102·9

In these equations W×0″·73 represents the correction to the coëfficient of variation, and V×3″·77 that to the coëfficient of parallactic inequality. We now know from recent special investigations that the latter coëfficient is very near 125″·50. Airy's provisional one was 122″·10, whence,

$$V = \frac{125''\cdot50 - 122''\cdot10}{3''\cdot77} = 0\cdot90.$$

The sum of the preceding equations gives

$$W = 2\cdot15 - 2\cdot90V = -0\cdot46.$$

The resulting correction to the provision variation (2370″·3) is therefore $-0\cdot46\times0''\cdot73 = -0''\cdot34$, making the variation derived from observation ..... 2369″·96,
while Hansen's theoretical value is ..... 2369 ·86,
and Delaunay's, ... 2369 ·74.
The differences are too minute to found any theory upon.

Leaving the evection and variation, the other inequalities are so minute that their product by Hansen's coëfficient is altogether insensible.

Summing up the results of our inquiry, it appears that in the case of the evection the supposed discordance between theory and observation would not follow from Hansen's hypothesis, and therefore, even if it exists, cannot be attributed to that hypothesis as a cause. In the case of the variation no such discordance has been proved. In the case of the other inequalities the discordance would be insensible.

The hypothesis is therefore devoid of logical foundation.

* Memoirs Royal Astronomical Society, vol. xxix.

Art. XL.—*Notices of papers in Physiological Chemistry*—No. II; by George F. Barker, M.D.

5. *On the formation of Sugar in the Liver.*

(1.) In November, 1848, Bernard and Barreswil announced to the French Academy* the discovery of a sugar similar to glucose, as a normal constituent of the liver, and exhibited a specimen of alcohol which they had prepared from it. This sugar, they maintained, could not be recognized in any other organ, although it was constantly present in the liver, even of animals whose food had been for a long time exclusively animal.

(2.) In a second communication, made to the Academy in October, 1850,† Bernard claimed to have demonstrated experimentally, during the two previous years, 1st, the constant presence of sugar in the liver, as a necessary condition of nutrition; 2d, the production of sugar as an especial function of the liver, independent of the particular food taken; and 3d, the dependence of the sugar-forming function upon nervous stimulus. The universality of this saccharine condition of the liver was established by experiments upon the principal classes of vertebrate animals, including man, as well as upon the mollusca among invertebrates. And his conclusion is that the blood which issues from the liver by the hepatic veins during digestion, is invariably saccharine, whatever the nature of the food. The amount of sugar, moreover, which is poured into the general circulation by the hepatic veins, diminishes with the activity of the digestive process; so that after a longer or shorter time, no sugar can be detected, either in the blood of these veins or in the tissue of the liver itself. The second point, the production of sugar by the liver, Bernard proved by feeding animals upon a diet exclusively animal, for four, five, or even eight months; at the end of this time, while no sugar could be detected either in the intestines, or in the blood of the portal vein, the blood of the hepatic veins was strongly saccharine. If therefore, the blood which enters the liver be free from sugar, and that which flows from it be rich in saccharine matter, it is evident that the sugar thus found has been supplied to it by the liver; and hence that this organ has the peculiar function of forming sugar. This sugar has been detected even in fœtal ivers; beside being readily fermentable, its solution is browned on being heated with alkaline hydrates, and easily reduces alkaline solutions of copper. Finally, the necessity of nervous

* C. R., xxvii, 514. † Ib., xxxi, 571.

stimulus to the production of sugar by the liver, was demonstrated by showing that this function ceased entirely on dividing the pneumogastric nerves of both sides in the vicinity of the heart.

(3.) The same year, C. G. LEHMANN published* the results of an extended research on the relative composition of portal and hepatic blood, made in order to elucidate the function of the liver. The experiments were made with horses; their food consisted of 2½ lbs. rye-bran, 2 lbs. chopped straw and 2 lbs. hay, and they were killed by injecting air into the jugular vein, 5 or 10 hours after eating. The blood was collected without admixture, and minutely examined. After describing the physical and morphological characters of the two varieties of blood, their chemical differences are considered. Portal blood contains fibrin, normal in amount and in properties; hepatic blood contains none. As to sugar, though abundant in the intestinal canal during the digestion of a mixed diet, Lehmann found that often it could not be detected in portal blood, though sometimes traces were present, and twice he was able to estimate it quantitatively. To examine for it, the alcoholic extract of the residue of the blood, was precipitated by a freshly prepared alcoholic solution of potassic hydrate, the precipitate dissolved in water containing tartaric acid, and examined either by fermentation or a copper-test. In portal blood 0·055 per cent (calculated on the dry residue) of sugar was found, and in the serum ·0052 per cent. In the hepatic veins on the other hand, sugar is not only uniformly present, but in larger amount than in the blood of any other vein. In three experiments, the dried residue of this blood gave 0·635, 0·893, and 0·776 per cent of sugar. In the hepatic blood of a dog fed on flesh, 0·838 per cent of sugar was found. Since therefore, the hepatic vein contains so much more saccharine matter than the portal, there can scarcely be a doubt of the formation of sugar by the liver. The remarkable disappearance of fibrin from the portal blood, may here find an explanation; since the protein bodies may, like salicin and similar substances, split into sugar and some other body containing their nitrogen.

(4.) In a paper published in 1851,† BAUMERT, after enumerating the intimate relations which exist between the different carbo-hydrates, and alluding to their rare occurrence in the animal organism, notices Bernard's investigations, and confirms them by experiments of his own. From 6 pounds of fresh sheep's livers, he obtained 3⅓ scruples of 70 per cent alcohol,

* Ber. d. K. S. d. Wiss. in Leipzig, 1850; J. pr. Ch., liii, 205.

† Jahresb. d. schles. Gesellsch. f. vaterl. Cultur, vol. xxviii; J. pr. Ch., liv, 357, Nov.

(sp. gr. 0·892); and from the liver of a fox fed for six weeks on flesh, and killed with strychnia, he obtained sufficient alcohol to recognize all its properties. He controverts the opinion that the hepatic sugar is simply retained there from a previous starchy food, since were this the case, the quantity of this sugar found in the herbivorous liver should be much greater than it is. Nor can glucose be carried to the liver during a meat diet, by the portal vein, since he was unable to detect it in portal blood, though his experiments were made with great care. Baumert also confirms Bernard's statement that sugar exists in the blood of the right ventricle, and considers it probable that it is oxydized in the lungs; though he was unable to demonstrate experimentally any of the intermediate products of this oxydation.

(5.) Dessaignes in 1854,* showed that the aqueous extract from the liver of the calf contained sugar, because, when mixed with chalk, and kept at a temperature of 25° to 35° C., it actively fermented, and yielded lactic acid, of the same kind as that produced from milk.

(6.) In January, 1855, Figuier presented a paper to the Academy† in which he sought to prove the existence normally of sugar in the blood of animals fed on a mixed diet, in amount equal to about one-half that found by Bernard in the liver; and, since the meat on which Bernard's animals were fed, came from the herbivora the blood of which contains sugar, he argues that the liver is an organ designed simply for storing up the sugar which reaches it by the portal vein. The amount of glucose which he found in the *liver* of rabbits was 1·3 per cent, and of cattle 1·4 per cent. In the *blood* of rabbits he found 0·57, in that of an ox 0·48, and in that of man 0·58 per cent. He also calls attention to the fact that the product of the action of the digestive fluids upon the albuminates, called albuminose, prevents the detection of sugar by the copper-tests.

(7.) In February, Longet published‡ the results of some careful experiments upon the influence exerted by albuminose upon the detection of sugar. He was never able to detect sugar in portal blood by the copper-test, even of animals living on a mixed diet. And he concludes from his research, that when the product of the transformation of a nitrogenous food by the gastric juice exists in the blood in considerable amount, and at the same time glucose in small amount, neither the copper-test, boiling with potassic hydrate, polarimetry, alcoholic fermentation, nor in a word, any other method in use, can demonstrate directly the existence there of the saccharine matter.

* J. pharm. III, xxv, 29; Jahresb., 1854, 405.
† C. R., xl, 228.
‡ Ib., p. 286.

(8.) In March, LEHMANN communicated to the Academy* the results already mentioned, together with some new facts. He found not a trace of sugar in the portal blood of dogs, either when fasting or fed on meat; when fed on boiled potatoes, however, traces were detected. In the hepatic blood, on the other hand, of three dogs fed on meat, 0·814, 0·799, 0·946 per cent of sugar was found; of three others, fasting for two days, 0·764, 0·638, 0·804 per cent; and of two others fed with potatoes, 0·981, 0·854 per cent. In arterial blood, sugar is rarely found. Lehmann was unable to detect it in that of horses fed on starch or oats, or of rabbits fed on sugar, or given a large quantity of beets or carrots.

(9.) To this paper, BERNARD added a note,† in which he says that the meat on which his animals were fed, was proved by analysis to be free from sugar; asserts that the sugar found in the general circulation is liver-sugar which has escaped oxydation in the lungs; controverts Schmidt's idea that sugar, like urea, is formed throughout the body and is simply excreted by the liver; remarks that the formation of sugar by the liver can no longer be disputed; and concludes that the only question remaining is, from what materials is this sugar formed. Since his researches have shown that the ingestion of fat diminishes the production of sugar, he is disposed to agree with Lehmann that it is formed from nitrogenous materials.

(10.) On the 26th of March, FIGUIER communicated‡ new experiments to prove the existence of sugar in portal blood. A young dog, large and vigorous, was fed, after three days fasting, with raw beef for eight days, then allowed to fast forty hours, and then given 2½ pounds of raw beef. Two hours after, an incision was made in the right side of the animal, the index finger introduced through the opening along the inferior border of the liver, and the portal vein seized and ligated. Then the abdomen was opened and the blood from the engorged portal vein collected. By opening the thoracic cavity, blood was obtained from the right ventricle and from the inferior vena cava. The portal blood weighed 102 grams; it was coagulated by the addition of three times its volume of alcohol, and the strained liquid acidulated slightly with acetic acid, was evaporated to dryness, dissolved in water and again evaporated; the residue weighed 1·07 grams. Its solution reacted readily with the copper-test; and by this means the sugar present was determined to be 0·248 per cent of the entire blood. The blood taken above the liver, which weighed 25 grams, left after the above treatment, 0·15 grams, and afforded only traces of sugar. On repeating the experiment with another dog fed for 12 days

* C. R., xl, 585. † Ib., p. 589. ‡ Ib., p. 674.

with raw beef, and examined four hours after taking food, the portal blood contained 0·231 per cent of sugar, the hepatic, 0·304 per cent. Hence the liver simply accumulates the sugar. He contends that his method of operating prevents regurgitation; and to prove it, he examined the portal blood 36 hours after eating, when it contained no sugar, while the liver was decidedly saccharine.

(11.) In a note to the Academy, presented on the second of April,* BERNARD says:

"Dans la dernière séance de l'Académie, on a nié l'exactitude de ces faits constatés et vérifiés par les hommes les plus compétents et les plus habiles.

"L'auteur qui a émis cette négation est arrivé non seulement à dire que chez les animaux carnivores, à certains périodes de la digestion, il y a du sucre dans le sang de la veine porte aussi bien que dans celui des veines hépatiques, mais il n'a pas craint d'avancer que deux heures après le repas, on trouve chez un chien qui a mangé de la viande de bœuf crue une plus forte proportion de sucre dans le sang de la veine porte que dans le sang pris au-dessus du foie.

"L'assurance avec laquelle une pareille assertion a été avancée pourrait peut-être en imposer à certaines personnes. C'est pourquoi je crois de mon devoir de venir déclarer ici que ces résultats sont entièrement inexacts." * * * * "Or je déclare de nouveau que j'ai toujours obtenu le résultat que j'avais annoncé, à savoir que chez un chien en digestion de viande cuite ou crue il n'y a pas de sucre dans la veine porte, ni une heure, ni deux heures, ni trois heures, etc., aprés le repas, et qu'il y en a au contraire dans les mêmes circonstances constamment et en notable proportion dans le sang des veines hépatiques."

(12.) At the same session, Bernard presented a note from Lehmann,† confirming his view that the hæmatin which disappears from the blood in considerable quantity in passing through the liver, is converted into sugar. He finds, 1st, that on dry distillation, hæmatin crystals yield at first an acid vapor, like the carbo-hydrates; and 2d, that on reducing the hæmatin dissolved in alcohol by nitrous ether, it yields a product which reduces the copper-tests, and which ferments, giving carbonic acid and alcohol.

(13.) On the 16th of April,‡ POGGIALE gave the results of his experiments made to decide the sugar-forming power of the liver, which in the main confirm Bernard's views.

(14.) At this session also, LECONTE, one of Majendie's assistants, who had aided Bernard in his investigations, communicated§ the method adopted at the College de France, for demonstrating the sugar-forming function. The animals experi-

* C. R., xl, 716. † Ib., p. 774. ‡ Ib., p. 887. § Ib., p. 903.

mented on were all killed by a section of the medulla; the portal vein was then ligated through an incision on the right side, the abdomen opened, and the inferior vena cava tied below the diaphragm. By cutting through this muscle, a second ligature was placed upon the vena cava, just above it. It was then easy to collect the hepatic blood without admixture, by introducing a glass tube into that portion of the vena cava included between the ligatures. The portal blood was obtained by means of a second tube introduced below the portal ligature. Experiment has shown that blood taken between this ligature and the liver always contains sugar, from regurgitation. The blood to be examined is mixed with three times its weight of strong alcohol, strained through linen, pressed out, the residues and vessels washed with alcohol, the whole filtered, acidulated with a few drops of acetic acid and evaporated on the water bath. The residue is mixed with water, a gram of fresh yeast is added, and the whole is introduced into a graduated bell-jar over mercury, standing in a warm place. A like quantity of the same yeast mixed with distilled water is used as a blank test, for comparison. After from 18 to 24 hours, the gas evolved is measured, the necessary corrections are made, and the amount of sugar calculated. Three careful quantitative examinations made in this way, showed no sugar in the portal blood of animals fed on meat, either raw or cooked; while under the same conditions the hepatic blood contained from one to four thousandths of its weight of sugar.

(15.) In May, 1855, F. W. Pavy communicated to the Royal Society* the results of his researches upon the disappearance of the liver-sugar from the circulation. By following the course of the arterial blood through the capillaries into the veins, he proved experimentally the gradual disappearance of the sugar throughout this course, though not with equal rapidity at all points; the capillaries of the chylopoietic viscera accomplishing it so perfectly that the portal blood is remarkably free from sugar, while that of the other large venous trunks, as the jugular and femoral, is considerably saccharine. Special investigation showed that the destructiou of sugar, which takes place principally in the lungs, is not dependent upon the amount of oxygen supplied there; and farther, that sugar does not disappear unless fibrin be present in the blood, both fibrin and oxygen being necessary, apparently, for its destruction. And inasmuch as the direct oxydation of glucose is not easy, Pavy suggests that under the influence of fibrin acting as a ferment, the sugar is split into lactic acid; an opinion which is strengthened by numerous ingenious experiments.

* Proc. Roy. Soc., vii, 371.

(16.) On the 18th of June, the Commission of the Academy, consisting of PELOUZE, RAYER, and DUMAS, to whom had been referred the papers of Figuier, Poggiale, and Leconte, made their report.* Confining themselves to a verification of facts, they state that since the universal presence of sugar in the liver, as the evidence of an important function of this organ, has never been contested, the questions to be settled, are its origin in this viscus, its use there, and its final disappearance. After enumerating the views of the authors named, the Report says that Bernard's view rests upon four data: 1st, the constant presence of sugar in the liver of all animals; 2d, the presence no less constant, of sugar in the hepatic veins; 3d, the absence of sugar in the portal blood of animals fed on animal food; and 4th, the temporary appearance of sugar in portal blood, when the food is amylaceous or saccharine. Of these points, two, the 1st and 4th, are universally admitted; it therefore remains only to ascertain if the portal blood of animals fed on meat, contains sugar. The Commission were unable to find a trace of sugar in their experiments. And on comparing the portal and the hepatic blood of the same animal, they found that while the portal blood contained not a trace of sugar, that of the hepatic veins contained it in appreciable quantity. They therefore remark, in conclusion; "la doctrine professée par notre confrère paraît intacte."

(17.) On the 27th of August, FIGUIER replied to this Report,† by asserting that the reason why sugar was not detected in the portal blood, was the presence there of some substance which prevented fermentation. He took a large dog which had been fed on horse-flesh for 8 days, supplied it with some of the same meat cooked, and 6½ hours afterward, ligated the portal vein as already described. The blood drawn from this vein, weighed when defibrinated, 700 grams; 600 grams of this were treated with 2½ volumes alcohol, strained from the coagulum, acidulated slightly with acetic acid, and evaporated on the water-bath. The residue was dissolved in water, the solution strained and divided into two portions; one of these was mixed with yeast under suitable conditions for fermentation, but with no result; the other portion was boiled for five minutes with a few drops of nitric acid, the clear yellow liquid exactly neutralized with sodic carbonate and mixed with well washed yeast. In 15 minutes, fermentation began and continued several hours; the gas evolved was absorbed entirely by potassic hydrate, and on distillation, alcohol, recognizable by its odor and its reduction of potassic dichromate with the odor of aldehyd, was

* C. R., xl, 1281. † C. R., xli, 352.

obtained. The experiment was repeated many times and always with the same result.

(18.) In a communication presented by BERNARD* on the 24th of September, he recapitulates the grounds on which he bases his new function of the liver, and reviews Figuier somewhat sharply, accusing him of shifting his ground in each of his three papers; he had himself repeated the experiments given in the last one with no result, no fermentation occurring even after boiling with acid. If, however, sugar be present in the portal blood, fermentation readily takes place, without preliminary treatment. Bernard then passes to the subject of his paper, "the mechanism of the glycogenic function of the liver." After alluding to the view of Schmidt (1849), that sugar is formed in the general circulation, of Lehmann that it is formed in the liver from fibrin or hæmatin, and of Frerichs that nitrogenous matters break up in the liver into urea and sugar—all of which views suppose the change to take place in the blood,—he advances the opinion that the glycogenic substance exists in the tissue of the liver itself. This view he sustains by the following experiment: a vigorous and healthy dog, fed for many days exclusively upon meat, was killed by section of the medulla, seven hours after a full meal of tripe. The abdomen was immediately opened, the liver carefully removed, and while yet warm, before coagulation of the blood had taken place, the portal vein was connected with the laboratory hydrant by means of a rubber tube, and water allowed to flow through the organ, escaping from the hepatic veins in a strong jet. Gradually the tissue of the liver became paler, and in 15 minutes the water was colorless. After 40 minutes, the escaping water contained not a trace either of sugar or of albuminoid matter; and on macerating a fragment of the viscus, no sugar was detected in the tissue. The liver was then allowed to remain exposed to the air for 24 hours, after which time sugar existed in it abundantly; even a little liquid remaining in the dish gave the reactions; and on injecting water into the portal vein, it issued strongly saccharine. The liver must therefore contain normally two substances: first sugar, very soluble in water, and easily removed by washing; and second, another body, sufficiently insoluble to remain after 40 minutes washing. This it is, which, when the liver is left to itself, changes into sugar. The change is prevented by cooking, and facilitated by chopping the organ fine; it is generally completed within 24 hours, the liver then containing as much sugar as at first; but a second fermentation is not possible, the material being exhausted. Bernard, moreover, proved the insolubility of this sugar-forming substance, in alcohol and ether; and showed that it is confined strictly to

* C. R., xli, 461.

the liver, not being recognizable in portal or in any other blood. It is absent from this viscus, whenever the conditions are such as to interfere with the production of sugar. This substance renewed incessantly under the influence of nutrition, is continually being transformed during life into saccharine matter, which replaces in the liver that which is constantly removed by flow of blood, into the hepatic veins. After death, the change continues until the material is exhausted; but then as the sugar is not removed, it accumulates in the liver-tissue; this is so charged with it, that it contains a considerably larger proportion of sugar the next day, than is found when the animal is killed.

(19, 20.) A second research by LEHMANN upon "the constitution of the blood of various vessels, with especial reference to the sugar it contains," was published during this year,* a portion of which was presented to the Academy Oct. 22d,† by Bernard. The experiments were made on the blood of five horses, by the methods already given, the analysis being made in duplicate. In the blood of the inferior vena cava, in three trials, 0·346, 0·311 and 0·492 per cent of sugar was found; but none could be detected in that of the jugular, external abdominal, or cephalic veins, nor in that of any artery. Though the uniformity of the analytical results ought to settle the question of the production of sugar by the liver, yet, as it has been strenuously denied, Lehmann thinks it of importance to examine the methods both chemical and physiological, which have been used. Of the former, the copper-test, either of Trommer, or as modified by Fehling, even when the materials used are pure, cannot be relied on for the detection of minute quantities of glucose in mixed fluids, since the precise action of all the substances present is not known. Hence Figuier's results, obtained with Fehling's solution in an alcoholic extract of portal blood, were not sustained by the Academy Commission, using the fermentation test. Longet's statement that albuminose (the peptone of Lehmann) prevents the copper reaction, is only partially true; since when sugar and albuminose are both present, the cupric oxyd is reduced, the blue solution changing to yellow, but with the formation of no precipitate. That albuminose hinders fermentation, is true only when the solution is so strong, that a similar solution of sugar would do the same. No true chemist, however, would think of testing directly a fluid containing much albuminose. German chemists, at least, use alcoholic extracts of these fluids, in which but a trace of albuminose exists. But, even in this, it is conceivable that there may be substances which will reduce the copper-test; since 1840, therefore, the sugar has been precipitated from the alcoholic extract for examination by

* Ber. d. K. S. Ges. d. Wiss. in Leipzig; J. pr. Ch., lxvii, 321. † C. R., xli. 661.

alcoholic potash. No substance which can interfere with the tests is thus thrown down, so that the copper-test may be directly used, or the solution, slightly acidified with tartaric acid, may be at once fermented. This method is one of great delicacy; sugar has been detected by it in urine, to which only $\frac{1}{1000}$ was added; and in many fluids where the reaction, as ordinarily applied, was doubtful or failed entirely, such as the urine of arthritis and tuberculosis, sugar was readily detected by this process. Moreover, glucose has thus been discovered in egg-albumin, in mammalian ovaries, and sometimes in mixed venous blood; but never in the bile or the saliva. As to the physiological method, it is evident that it should furnish blood such as flows in the veins during life. This is especially necessary with portal blood, as at death there is a stasis of blood in the liver; and, since the nutrient arteries of the liver pour their blood, not into the hepatic vein, but directly into the portal capillaries, there may easily be regurgitation of blood containing sugar. Though Figuier has avoided this source of error, he has fallen into another; it needs no deep insight into the distribution of the blood to perceive that the 400 grams of portal blood which he took is far more than the normal content of that vein, even in a very large dog. According to the analysis of Bischoff and Welker, the blood constitutes not more than $\frac{1}{13}$ of the bodily weight of an animal; in a dog of 24 kilograms, there cannot be more than 2 kilograms of blood. To suppose that the 400 to 700 grams taken from the portal vein of such an animal is pure portal blood, is to make the absurd assumption that $\frac{1}{4}$ of all the blood is found in the portal system. To avoid these errors, Lehmann proceeds as follows: The dog is killed by a blow on the head, the portal vein tied through a small opening, as Bernard suggests, the abdominal cavity opened quickly, a noose placed 10 or 15 m.m. below the ligature, the blood pressed toward the mesenteric and splenic veins, an opening into the empty vein made with scissors, a glass tube bent twice at right angles inserted, the noose drawn tight about the tube, and the blood allowed to flow through it. In this way, 213 grams of blood were collected; but this was too much, as analysis proved. Within four months, 32 dogs were operated on in this way; after fasting for 24 hours, they were fed with raw horse-flesh, and killed 3, 4, 5, or 6 hours subsequently. In 16 of these, from whom from 35 to 81 grams of portal blood were taken, not a trace of sugar was detected. In order to see whether any difference would result from taking a larger quantity from the living animal, 351 grams were taken from a dog weighing 13 kilos., 211 grams from one of 11·5 kilos., and 263 grams from a third weighing

14·5 kilos.; and in all of these specimens, as in that of 213 grams above mentioned, sugar was found; thus proving foreign admixture in the blood examined by Figuier. Lest it be said that the quantity examined was insufficient, Lehmann united the blood of six dogs in two portions; that of the first three weighed 217·5 grams; that of the second three, 192·7 grams; the result was the same. Experiments made to ascertain whether the portal vein contained any substance capable of yielding sugar, were entirely without result; as also were those made to discover the presence of any material which prevented the reactions for sugar.

(21.) At the conclusion of this paper, Bernard remarked that the glycogenic function of the liver, as at first enunciated by him, was now incontestibly proven.

(22.) In a paper published by HENSEN,* he confirmed Bernard's view that the liver contains an insoluble body which is converted into sugar by the action of a ferment, by acting on the substance of the boiled liver by the salivary and pancreatic ferments, and thus producing sugar; he also converted starch into sugar by means of the liver ferment.

(23.) POGGIALE, in a communication to the Academy in Feb. 1856,† contests the opinion that the presence of an alkaline carbonate in the blood is necessary to the destruction of sugar, and hence that its appearance in diabetic urine is due to a deficiency in this respect; since he finds that the addition of hydro-sodic carbonate to the food of dogs produces no effect on the amount of sugar in the blood; and that sugar when injected into the blood, appears equally in the urine whether dissolved in pure water or mixed with twice its weight of the carbonate.

(24.) On the 26th of May, 1856, CHAUVEAU published‡ the following results: 1st, during very prolonged abstinence, sugar never disappears from the general circulation; 4 horses and 4 dogs fasting from 12 hours to 6 days, had in their venous blood from ·066 to ·080 per cent of sugar for the former, and ·029 to ·034 per cent for the latter; in the arterial blood, from ·073 to ·093 per cent for the horses, and ·035 to ·053 for the dogs: 2d, sugar is more abundant in the arteries than in the corresponding veins: 3d, arterial blood wherever taken, contains the same amount of glucose; that examined was from the coccygian, femoral and carotid arteries, and from the left ventricle: 4th, venous blood, except portal during the digestion of starchy or saccharine matters, hepatic, and that of the inferior vena cava above the diaphragm, shows no appreciable variations in

* Verh. d. phys.-med. Ges. zu Würzburg, vii, 219; Jahresb., ix, 705.
† C. R., xlii, 198. ‡ Ib., p. 1008.

the amount of glucose: 5th, with animals fasting or fed on meat, hepatic blood is more saccharine than any other: 6th, the quantity of sugar is the same in both sides of the heart: 7th, pure lymph is always saccharine, even after prolonged abstinence: and 8th, this sugar is not absorbed from the tissues by the lymphatics, since no tissue except the liver contains it. His conclusions are as follows: 1st, herbivorous blood contains more sugar than carnivorous: 2d, the sugar in the right side of the heart is not destroyed in the lungs and hence appears in the left side: 3d, a certain quantity disappears in the capillaries, the returning blood containing less than the issuing: 4th, the sugar is not fixed by the solids of the body; a part filters to the lymphatics, and a part is metamorphosed; 5th, the blood approaching the right side of the heart has its sugar increased by that in the chyle: 6th, sugar is re-supplied to the blood by the hepatic veins: 7th, the sugar thus furnished does not exist in the portal blood of animals, either fasting or fed with meat; it comes from the liver, which is therefore a true producer of sugar.

[*To be continued.*]

ART. XLI.—*Observations of the Auroras of Sept. 5th and 15th, 1868, at Mt. Desert Island, Maine* (lat. 44° 20′ N., long. 68° 15′ W.); by W. S. GILMAN, Jr.

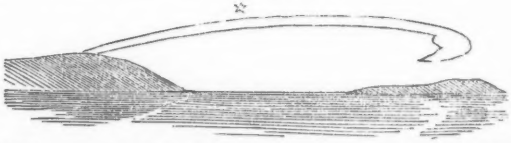
ON the evening of Sept. 5th, 1868, there was a fine aurora here. At 8 P. M. streamers shot up in the north and N.N.E.; one large ray attained an altitude of about 50°. These streamers moved toward the west. At $9^h\ 15^m$ a long thin cloud-like arc spanned the heavens from east to west, passing to the north of ζ Pegasi, γ Delphini, γ Sagittæ and α Ophiuchi. Near the meridian its breadth was about a degree, and it was broken into short parallel bands of light.

At $9^h\ 30^m$ the arc of light was more to the south, bordering on the Dolphin and Arrow. At $10^h\ 30^m$ aurora faintly visible under Polaris.

On the evening of Sept. 15th, from 7^h until $11^h\ 30^m$, there was a remarkably fine display of the aurora here. On the 14th, from 9 to 10 A. M., I had noticed dusky beams in the N.N.E. not unlike those proceeding from a very regular night aurora. They did not appear further west than the north point, and rose above the horizon about 10°. No aurora was marked during the evening of the 14th.

On the 15th, at 7 P. M., several short beams in the N.N.E. moving slowly westward. At $7^h\ 25^m$ an auroral arc from Algol

to Capella less than a degree broad, quite bright, and shaped like a whale's rib. The right end curves downward toward the horizon, as shown in the accompanying sketch.



At 7^h 35^m a second luminous arc formed about half way to Algol.

At 7^h 42^m brilliant beams between Capella and Polaris.

7^h 55^m. Brightest part of arc has shifted to westward, and is directly under the Bear's head. Sheets of light going up from Polaris west.

8^h 15^m. The arc is curiously shaped; the upper edge is like the outline of a huge mountain. To the east the arc drops down toward the horizon and ends in a twisted cloud of light.

8^h 55^m. Auroral cloud spans the heavens. Origin in east about 8° above horizon, between Jupiter and α Trianguli. Moved slowly southward.

9^h 0^m. The highest part of arch is now at β Cygni.

10^h 20^m. Streamers in sheets—lower edge foliated like the plaits in a garment.

10^h 30^m. The north appears covered with great rolls of light like so many huge rolls of cloth. The sheets of light appear to be rolling and unrolling from E. to W. and from W. to E. To the west the sheets seem to disappear around the edge of a circle, as if part of concentric cylinders of light suspended above the pole of the earth. The folds bear a striking resemblance to a gauze curtain agitated by a strong wind.

10^h 45^m. The twisted beams began to flicker from the horizon upward like vast flames from a great conflagration. There were two or three flashes to a second. The flames passed the zenith and went over to the western horizon. The heavens now appeared all afire to the north and up to the zenith, the flames ascending from the entire northern horizon from the E. to the W. point.

11^h 0^m. The flickering can be seen to within 8° or 10° of Fomalhaut in the south.

11^h 10^m. Flashings cover more than half the sky to within about 20° of southern horizon.

11^h 30^m. Flashing light still continues but is growing much less distinct. Heavy mass of clouds obscured the northern sky under Polaris.

[The preceding notes are extracted from a very minute report

of these auroras furnished us by Mr. Gilman. If any other observer, favorably situated, has carefully noted the same phenomena, and will communicate his observations to us, we will institute a comparison of the observations, and make a report of the results. In order to determine the height of these auroral exhibitions, it is desirable to obtain simultaneous observations at two places situated near the same magnetic meridian, and at a distance from each other of about 100 miles.—EDS.]

ART. XLII.—*Discoveries of new Planets.* (Communicated by Prof. J. C. WATSON of Ann Arbor.)

Planet (103).—The following are my observations on the new planet (103) discovered by me on Sept. 7th:

Ann Arbor M. T.				(103) α			(103) δ			Comp.	
1868. Sept.	7,	15^h	31^m	46^s	0^h	22^m	$13^s{\cdot}18$	$-3°$	$49'$	$51''{\cdot}3$	9
	9,	14	45	42	0	20	53 ·94	− 4	3	47 ·0	1
	10,	9	59	59	0	20	20 ·66	−4	9	24 ·5	7

The planet is of the 10th magnitude.

New planet (104); (communicated Sept. 14th).—I have the pleasure to send you the following observations of a new planet which I discovered last night:

Ann Arbor M. T.					α			δ			Comp.	*
1868. Sept.	13,	11^h	35^m	9^s	0^h	20^m	$25^s{\cdot}61$				2	*a*
	13,	12	35	52	0	20	23 ·65	$-1°$	$10'$	$52''{\cdot}6$	4	*b*
	13,	13	1	33	0	20	22 ·56	1	10	48 ·0	2	*c*
	13,	15	55	57	0	20	17 ·38	−1	11	23 ·7	10	*c*

Daily motion, $\Delta\alpha = -45^s$ $\Delta\delta = -5'$.

The planet is of the 11·5 magnitude.

Planets (102) *and* (105); (communicated Sept. 18th).—On the 23d of August, Dr. C. H. F. Peters of Clinton, N. Y., discovered minor planet (102). He proposes to call it *Miriam*, and has communicated the following observations:

Clinton M. T.					(102) α			(102) δ		
1868. Sept.	13,	12^h	48^m	30^s	1^h	14^m	$1^s{\cdot}93$	$+12°$	$8'$	$50''{\cdot}3$
	14,	13	17	23	1	13	40 ·13	12	3	57 ·1

Planet 11th magnitude.

The discoveries of minor planets (103) and (104) have already been communicated to you. I have yet to add that I discovered still another planet on the 16th inst., of which I have observed the following places:

Ann Arbor M. T.					(105) α			(105) δ		
1868. Sept.	16,	16^h	3^m	15^s	0^h	13^m	$47^s{\cdot}42$	$+6°$	$12'$	$4''{\cdot}9$
	16,	16	33	22	0	13	46 ·28	6	11	45 ·3
	17,	10	29	16	0	13	10 ·57	+6	1	7 ·2

The planet is somewhat brighter than a star of the twelfth agnitude.

Discovery of Planet (106), *and new observations on* (100), (101), (102), (103), (104), (105); (communicated Oct. 13th).—I have observed the following places of a new planet discovered by me on the 10th inst.:

Ann Arbor M. T.	(106) α	(106) δ
1868. Oct. 10, $10^h\ 36^m\ 37^s$	$1^h\ 1^m\ 21^s{\cdot}84$	$+0°\ 31'\ 42''{\cdot}5$
11, 11 0 19	1 0 34 ·33	0 28 31 ·0
12, 10 26 52	0 59 48 ·72	+0 25 31 ·2

The planet resembles a star of the tenth magnitude.

The following are my latest observations of the other new planets:

Hecate (100).

Ann Arbor M. T.	α	δ
1868. Oct. 11, $8^h\ 31^m\ 58^s$	$20^h\ 42^m\ 59^s{\cdot}68$	$-21°\ 0'\ 32''{\cdot}4$
12, 7 26 57	20 43 36 ·02	—20 59 9 ·6

Helena (101)

Oct. 11, 10 12 55	23 5 18 ·35	— 0 24 38 ·6
12, 8 2 0	23 4 50 ·75	— 0 24 2 ·4

Minor Planet (102), [*Peters.*]

Oct. 11, 11 54 10	0 57 22 ·67	+ 8 43 46 ·4
12, 10 53 37	0 56 42 ·78	+ 8 35 15 ·7

Minor Planet (103).

Oct. 11, 14 32 19	23 57 6 ·49	— 7 24 29 ·6
12, 9 59 13	23 56 36 ·69	— 7 27 52 ·2

Minor Planet (104).

Oct. 11, 13 1 49	23 59 34 ·97	— 3 0 22 ·9
12, 9 2 15	23 59 1 ·45	— 3 2 52 ·1

Minor Planet (105).

Oct. 11, 12 29 56	23 54 45 ·95	+ 0 16 50 ·8
12, 8 32 37	23 54 14 ·83	+ 0 6 2 ·3

Elements of (100) *and* (101); (communicated Oct. 26th).—I have determined the elements of the orbits of two of these planets, and have obtained the following results:

Hecate (100).

Epoch = 1868, Sept. 1·0 Washin'n M. T.

M =	10° 5′ 30″·4	
π =	304 45 0 ·5	Ecliptic and
Ω =	128 28 37 ·7	mean equinox
i =	6 33 34 ·6	1868·0.
ϕ =	8 39 32 ·5	
log a =	0·493331	
log μ =	2·810010	
μ =	645″·669	

Helena (101).

Epoch = 1868, Sept. 13·5 Washin'n M. T.

M =	17° 48′ 53″·0	
π =	328 40 51 ·0	Ecliptic and
Ω =	343 35 0 ·1	mean equinox
i =	10 4 19 ·5	1868·0.
ϕ =	8 0 48 ·1	
log a =	0·410460	
log μ =	2·934317	
μ =	859″·640	

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On the combustion of hydrogen and carbonic oxyd in oxygen under great pressure.*—In a communication made to the Royal Society in 1861, Dr. FRANKLAND pointed out the remarkable law that in combustion the diminution in illuminating power is directly proportional to the diminution in atmospheric pressure. The same writer has now renewed the subject, and has presented the results of his study of the influence of an increase of pressure. Dr. Frankland in the first place calls attention to the fact that the theory of Davy, now commonly received, that the illuminating power of a flame depends upon the deposition and ignition of solid particles in the flame, does not hold good for numerous cases. Thus arsenic burns with great brilliancy in oxygen, forming arsenous oxyd, yet arsenic is volatile at 180° C. and arsenous oxyd at 218° C., while the temperature of the incandescence of solids is at least 500° C. A mixture of the vapor of carbonic disulphid with oxygen burns with an extremely brilliant light, but no presence of solid particles can be admitted. The result is the same when nitric oxyd is substituted for oxygen, the flame being then very rich in the more refrangible rays. The combustion of phosphorus in oxygen furnishes another case in point, since phosphoric anhydrid is volatile at a red heat.

The author's experiments on the combustion of hydrogen and carbonic oxyd in oxygen were conducted in a strong iron vessel furnished with a thick plate of glass to permit of optical examination of the flame. The feeble light emitted by hydrogen burning under the ordinary pressure is well known. An increase to two atmospheres produces a visible augmentation, while at a pressure of ten atmospheres the light of a jet one inch long is sufficient to enable the observer to read a newspaper at a distance of two feet from the flame. The spectrum of this flame is bright and continuous from red to violet. The flame of carbonic oxyd in oxygen is more luminous under a pressure of ten atmospheres than the hydrogen flame under the same pressure. When burnt in oxygen under a pressure of fourteen atmospheres the spectrum of the flame is very brilliant and perfectly continuous. When the electric spark is passed through different gases the light is more intense in the cases of those gases which have the greater density. It is particularly brilliant when passed through a tube containing liquid sulphurous acid. If a stream of induction sparks be passed through air condensed in a glass tube by a pump, a marked increase in the light will be observed as the pressure of the air is increased, and the phenomenon occurs in a reverse order when the condensed air is allowed to escape.

The electric arc from fifty Grove's cells is incomparably more brilliant in the vapor of mercury than in air. The author remarks

that these results have a very direct bearing on the views now held regarding the constitution of the stars and nebulæ, and promises to make the application when his complete memoir is laid before the Royal Society.—*Proc. Royal Society*, xvi, 419.

W. G.

2. *On the reduction and saturation of organic compounds by hydrogen.*—Since the publication of our abstract of BERTHELOT's first three papers on this subject we have received another portion of his complete memoir, from which we extract the following as the most salient points:

(1) Complex and polymeric carbids.

1st section—complex carbids. Allyl or allyl propylene, $C_{12}H_{10}$, heated with a solution of iodhydric acid saturated in the cold gives a new liquid hydrocarbon and a gas in small quantity. The formation of these substances is represented by the equations

$$\underset{\text{Allyl.}}{C_6H_4(C_6H_6)}+2H_2 = \underset{\text{Hydruret of dipropylene.}}{C_6H_6(C_6H_8)}$$

$$C_6H_4(C_6H_6)+3H_2 = \underset{\text{Hydruret of propylene.}}{2C_6H_8}$$

2d section—complex carbids of the aromatic series.

Phenyl, $C_{24}H_{10}$, by taking up hydrogen under the action of an excess of iodhydric acid yields hydrid of hexylene as principal product:

$$C_{24}H_{10}+9H_2 = 2C_{12}H_{14}.$$

With less iodhydric acid it yields as chief product benzine:

$$C_{24}H_{10}+H_2 = 2C_{12}H_6,$$

and as secondary products carbon, hydrid of propylene and free hydrogen.

Styrolene yields hydrid of octylene as chief product:

$$C_{16}H_8+5H_2 = C_{16}H_{18},$$

and less abundantly the hydrids of hexylene and ethylene:

$$C_{16}H_8+6H_2 = C_{12}H_{14}+C_4H_6.$$

With a less quantity of the hydracid, styrolene yields hydrid of styrolene:

$$C_{16}H_8+H_2 = C_{16}H_{10},$$

and less abundantly benzol and hydrid of ethylene:

$$C_{16}H_8+2H_2 = C_{12}H_6+C_4H_6.$$

Ethyl benzine, $C_{16}H_{10}$ or $C_{12}H_5(C_4H_5)$, gives as chief product hydrid of octylene:

$$C_{16}H_{10}+4H_2 = C_{16}H_{18},$$

this last being perhaps hydrid of ethyl-hexylene, $C_{12}H_{13}(C_4H_5)$. In smaller proportion the author obtained also the hydrids of hexylene and ethylene.

3d section—complex pyrogenic carbids.

Naphthalin, $C_{20}H_8$, treated by iodhydric acid yields successively the following products: 1st hydrid of naphthalin, $C_{20}H_{10}$; 2d hydrid (?) $C_{20}H_{12}$, diethyl benzine, $C_{20}H_{14}$, hydrid of diethyl

benzine, $C_{20}H_{22}$, ethyl benzine and hydrid of ethylene, $C_{13}H_{10}+C_4H_6$, hydrid of ethyl-hexylene and hydrid of ethylene, $C_{16}H_{18}+C_4H_6$, benzine and hydrid of ethylene, $C_{12}H_6+2C_4H_6$, hydrid of hexylene and hydrid of ethylene, $C_{12}H_{14}+2C_4H_6$. Of these the normal or complete product is hydrid of decylene, $C_{20}H_{22}$.

Perchlorinated naphthalin, $C_{20}H_8$, yields as chief product hydrid of ethylhexylene, the reaction being

$$C_{20}Cl_8+32HI = C_{16}H_{18}+C_4H_6+8HCl+16I_2.$$

Anthracene, $C_{28}H_{10}$, yields as chief product hydrid of tetradecylene:

$$C_{28}H_{10}+10H_2 = C_{28}H_{30};$$

a notable quantity of hydrid of heptylene and smaller quantities of the hydrids of hexylene and ethylene. With an insufficient quantity of hydracid, anthracene gives toluene, $C_{14}H_8$, traces of benzine and hydrid of ethylene, and a small quantity of what may be hydrid of anthracene, $C_{28}H_{12}$.

Alizarine, $C_{28}H_8O_8$, in presence of a large excess of hydracid is completely changed into saturated carbids, among which are the hydrids of octylene and hexylene.

Phthalic acid, $C_{16}H_6O_8$, yields as principal product hydrid of heptylene, $C_{14}H_{16}$, and a small quantity of hydrid of octylene, the last being the normal product:

$$C_{16}H_6O_8+10H_2 = C_{16}H_{18}+4H_2O_2.$$

Terephthalic acid, $C_{16}H_6O_8$, yields hydrid of heptylene:

$$C_{16}H_6O_8+7H_2 = C_{14}H_{16}+C_2O_4+2H_2O_2.$$

—*Bull. de la Societe Chimique de Paris*, 1868, p. 265. W. G.

3. *On the persulphid of hydrogen.*—The constitution of persulphid of hydrogen has hitherto remained doubtful. Dr. A. W. Hofmann has taken advantage of the fact that great quantities of this substance are produced in certain technical processes at Dieuze to examine its constitution anew, and has succeeded in rendering it certain that there is a persulphid having the formula H_2S_3. When a cold saturated solution of strychnine in strong alcohol is added to an alcoholic solution of persulphid of ammonium, brilliant crystalline spangles soon appear, and after 12 hours beautiful orange-red needles are formed, which after washing with cold alcohol are perfectly pure. They are insoluble in water, alcohol, ether and bisulphid of carbon; in fact, the author has found no solvent from which they can be recrystallized. Analysis leads to the formula

$$C_{21}H_{24}N_2O_2S_3 = C_{21}H_{22}N_2O_2+H_2S_3.$$

In contact with sulphuric acid the crystals are decolorized, and on adding water colorless transparent oily drops of persulphid of hydrogen are separated, which after some time are resolved into sulphur and sulphuretted hydrogen. Quinine, cinchonine, benzine and some other alkaloids gave no analogous compounds.—*Proc. Royal Society*, xvi, p. 437. W. G.

4. *On the compounds of molybdic and phosphoric acids.*—DEBRAY has discovered and partly described a remarkable series of bodies formed by the combination of phosphoric and molybdic acids, and closely related in general character to the silico-tungstates of Marignac. The yellow precipitate which molybdate of ammonia forms in a solution of phosphoric acid, or a phosphate rendered acid by nitric acid, when boiled in nitro-muriatic acid, gives a yellow liquid which on evaporation yields beautiful doubly oblique prisms containing one equivalent (old style) of anhydrous phosphoric acid and 20 equivalents of anhydrous molybdic acid, together with about 13·3 per cent of water. Two other hydrates exist, of which one, crystallizing in large regular octahedra, contains 23·4 per cent of water, while the other, crystallizing in rhombic prisms, contains 19·6 per cent of water. The quantity of phosphoric acid in these compounds amounts to only 3·7 to 4·1 per cent, yet it modifies the properties of the molybdic acid in a very remarkable manner. Phosphomolybdic acid precipitates from strongly acid solutions potash, the oxyds of cæsium, rubidium and thallium, ammonia and the organic alkaloids. Sodium and lithium give no precipitates under these circumstances; the same is the case with the heavy metallic oxyds when the solutions are sufficiently acid. The yellow phosphomolybdates of potassium, thallium and ammonium have the general formula

$$3RO . PO_5 . 20MO_3.$$

The potassic and ammonic salts contain 3 equivalents of water. A solution of phosphomolybdic acid precipitates argentic nitrate; the precipitate gradually becomes crystalline and has the formula

$$7AgO . PO_5, 20MO_3 + 24HO.$$

Dilute nitric acid dissolves this salt; from the solution crystals are formed having the formula

$$2AgO . PO_4 . 20MO_3 + 7HO.$$

The phosphomolybdates are only stable in the presence of acids; alkalies transform them into ordinary molybdates and phosphomolybdates, in which the two acids are united in the ratio of 1 to 5:

$$PO_5, 20MO_3 + aq = PO_5 . 5MO_3, aq + 15MO_3.$$

These phosphomolybdates are colorless or nearly so and have a nacreous lustre; they are soluble in water and crystallize easily. An excess of acid brings them back to the condition of the yellow phosphomolybdates, setting free phosphoric acid:

$$4(PO_5, 5MO_3 + 10aq = 3(PO_5, 3HO) + PO_5, 20MO_3 + aq.$$

The following are some of the most beautiful salts of this second class of phosphomolybdates:

$$6(NH_4O), 2PO_5, 10MO_3 + 14HO$$
$$6KO . 2PO_5 . 10MO_3 + 14HO$$
$$6NaO . 2PO_5 . 10MO_3 + 28HO$$
$$6AgO . 2PO_5 . 10MO_3 + 14HO.$$

These formulas are not divisible by *two*, as the salts in question yield by careful treatment with acids a new series of crystalline salts, having the general formula

$$5RO \cdot 2PO_5, 10MO_3 + Aq.$$

A double salt of one of the above acids with potassic nitrate has the formula

$$6KO \cdot MO_5 + 6KO \cdot 2PO_5 \cdot 10MO_3 + 18HO.$$

In conclusion, the author gives a new method of analysis suitable to the above-mentioned compounds, for which, however, we refer to the original memoir.—*Comptes Rendus*, lxvi, 702. W. G.

5. *On iodid of silicon and silico-iodoform.*—FRIEDEL has obtained the iodid of silicon, SiI_4, by passing the vapor of iodine mixed with dry carbonic acid gas over silicon heated to redness. After purification the iodid forms colorless transparent octahedral crystals, fusing at 120°·5 C., and boiling at about 290° C. Water decomposes it, forming silicon and iodhydric acid. The density of its vapor was found to be 19·12, theory requiring 18·56. Alcohol acts upon iodid of silicon to form silica and iodid of ethyl according to the equation

$$SiI_4 + 2C_2H_5O = SiO_2 + 2C_2H_5I + 2HI.$$

The substance obtained by Buff and Wöhler by the action of iodhydric acid upon silicon was found, as in the analogous case of the action of chlorhydric acid, to consist of a mixture of silico-iodoform, $SiHI_3$, and iodid of silicon. The former is, when pure, a very heavy colorless liquid, highly refractive, and boiling at about 220° C. Its density is 3·362 at 0° C., and 3·314 at 20° C., without correction for the dilatation of the glass, so that it is almost as heavy as the thallic alcohol of Lamy.—*Comptes Rendus*, lxvii, p. 98. W. G.

6. *On the density of the vapor of calomel.*—The density of the vapor of calomel was determined by MITSCHERLICH, and more recently by H. SAINTE-CLAIRE DEVILLE and TROOST, who found for it the number 8·21, which agrees with the theoretical number 8·51, which we obtain if we suppose that the formula HgCl corresponds to 4 vols. (H=1 representing 2 vols). Those chemists who represent calomel by the formula Hg_2Cl, suppose that at the temperature at which the vapor-density is taken the vapor is resolved into a mixture of Hg and HgCl, each of which occupies 4 vols. Debray has found, however, that at the temperature of 440° C., at which the vapor-density is taken, a plate of gold plunged into the vapor preserves its color and luster, and is not amalgamated. On the other hand, a plate of gold plunged into the vapor of biniodid of mercury at a temperature near to redness becomes so brittle that it may be rubbed to pieces between the fingers. From this it follows that calomel must be classed among substances which correspond to 8 vols. of vapor.—*Comptes Rendus*, lxvi, p. 1339.

W. G.

7. *Connotations of Magnetism;* by PLINY EARLE CHASE.—The following summary gives the principal points of the generally accepted theory of terrestrial magnetism, together with such modifications as seem to be warranted by the foregoing considerations. Although I can hardly imagine the possibility of essential change

in any particular, I submit it as a merely provisional statement, subject to such future amendments as may be required by the progress of discovery.

1. The earth is an electro-magnet, magnetized by currents which are excited by the sun and by the earth's rotation.

2. Terrestrial magnetism is subject to a variety of disturbances, some of which are periodical, others irregular and occasional.

3. The principal periodical disturbances vary: 1st, with the solar hour; 2d, with the season of the year; 3d, with the relative distance of the earth from the sun; 4th, with the rapidity of the earth's orbital motion; 5th, with the rapidity of change in solar declination; 6th, with the absolute hour, in reference to magnetic meridians in the Pacific and Atlantic oceans; 7th, with the lunar hour; 8th, with the lunar declination; 9th, with the position of the principal planets (sun-spot period); 10th, with change of climate (secular variation). All these disturbances (the last, perhaps, excepted) appear to be transmitted with the speed of gravity, and they may all be grouped under two heads; 1st, change of relative position; 2d, change of relative velocity between the disturbing and the disturbed body.

4. The principal occasional, or irregular disturbances, seem to be dependent upon, 1st, irregular variations in the light or heat transmitted from the sun; 2d, similar variations in the diathermancy or transparency of the earth's atmosphere; 3d, local accumulations of heat or cold; 4th, electric and other local meteoric changes; 5th, atmospheric or terrestrial agitation (cyclones, earthquakes, volcanic eruptions, &c.). These disturbances are, of course, transmitted with velocities varying from that of light or of electricity to that of sound-waves, or even to that of still more sluggish vibrations.

5. The periodical and the occasional disturbances are all modified by mutual interaction. The phenomena are thus complicated, and the difficulty of satisfactory investigation is largely increased.

6. The sources of disturbance are, therefore, multiform; some are celestial, and others terrene; some cosmical, and others local in their origin. They all, however, have this common feature: each is capable of occasioning fluid currents.

7. Every disturbance of terrestrial magnetism is accompanied by a disturbance of terrestrial gravitation.

8. The gravitating atmospheric currents, which are originated simultaneously with the magnetic disturbances, become, in their turn, the source of secondary disturbances.

9. However the disturbance is produced, be it primary or secondary, periodical or occasional, there is an immediate tendency to equilibrium, and that tendency is in the direction of the terrestrial gravitation of fluids.

10. The regular disturbances by the sun's heat and attraction, combined with the rotation and attraction of the earth, produce revolving currents analogous in form to those which circulate around ordinary magnets.

11. Similar revolving currents must be excited about the sun, and about every other rotating celestial body. Such bodies, therefore, may become, like the earth, electro-magnets, or the seats of a specific magnetism.

12. If the specific magnetism is to be measured by the intensity of the exciting disturbance, the sun may be, relatively, the weakest magnet in our system; if it is to be measured by the intensity of the equilibrating force, it is probably proportioned to the force of gravitation at the surface of the magnetized orb.

13. It seems probable that the specific cosmical magnetism, like that of a permanent magnet or of an ordinary electro-magnet, reacts inductively. But I know of no good reasons for supposing that such induction is other than a comparatively unimportant, secondary and subordinate action.

14. The lunar primary disturbances, so far as has hitherto been ascertained, appear to belong exclusively to the first class of periodical disturbances, those which are due to change of relative position. It seems most likely, however, that there may also be lunar periodical disturbances of the second class.

15. The resemblance of the lunar diurnal magnetic curves to the normal tidal curve indicates a close correspondence between lunar magnetism and lunar gravitation.

16. Magnetism does not seem to be, strictly speaking, a simple or independent force, but, like the central force of an eddy, the resultant of revolving currents, moving with a speed which is, probably, at least as great as that of light at the surface of the magnetized body.

17. Terrestrial and cosmical magnetism can be satisfactorily accounted for by the hypothesis that all the magnetic eddies are produced by the action of gravity in the restoration of disturbed equilibrium. No known force, other than gravity, has a known velocity sufficient to enable it to act promptly, as an equilibrating force, in all the known cases of magnetic disturbance.—(*Proc. Amer. Phil. Soc., Feb.* 21, 1868.)

II. MINERALOGY AND GEOLOGY.

1. *On a new Mineral in Cryolite;* by THEO. D. RAND.—This mineral, for which I propose the name *Ivigtite*, from its locality, was first observed in 1866, but only recently has been obtained in sufficient quantity for examination.

It occurs disseminated in films and seams through massive cryolite—sometimes forming a coating between crystals of carbonate of iron and the cryolite in which the carbonate is imbedded. Color, pale yellowish-green, sometimes yellow. Structure, fine granular, approaching micaceous. Hardness, 2—2·5. Sp. gr. 2·05. B. B. alone blackens slightly and fuses rather easily to a white slag. With carbonate of soda fuses readily and with effervescence to a greenish bead. In borax dissolves readily with an iron reaction. In microcosmic salt dissolves readily except silica skele-

ton; bead yellow while hot, bluish opalescent when cold. In closed tube yields acid water.

With considerable difficulty 0·679 gram of the mineral, free from admixture, was obtained and submitted to anlysis with the following percentage result:

Water,	3·42
Fluorine,	·75
Silica,	36·49
Sesquioxyd of iron,	7·54
Alumina,	24·09
Soda,	16·03
Loss,	11·68
	100·00

The very small quantity of the mineral which could be procured prevented a more satisfactory result, but from the foregoing characteristics I feel justified in pronouncing it a new species, and hope that a larger quantity may be procured and a correct analysis made.

Pachnolite, besides its usual occurrence in honey-combed cryolite, nearly or always in juxtaposition with the so-called Hagemannite, has been observed in crystals implanted on massive cryolite, and also coating crystals of the latter, mixed with microscopic crystals of cryolite. The crystals of pachnolite are always small, rarely exceeding the fiftieth of an inch in diameter, but those of cryolite have been found measuring over $\frac{3}{10}$ths of an inch cube. The crystals of carbonate of iron, found in the cryolite, have probably never been excelled for beauty. They are usually simple rhombohedrons, often of fine polish, and measuring from half an inch to four inches across. A black blende, containing much iron, has been found in the massive cryolite, crystallized in perfect octahedrons.—*Proc. Acad. Sci. Philad.*, 1868, 142.

2. *Notes on the Later Extinct Floras of North America, with Descriptions of some New Species of Fossil Plants from the Cretaceous and Tertiary Strata;* by J. S. Newberry.*—The following are the observations in this paper preceding the descriptions of species:

It is only within the last ten years that we have obtained any information whatever in regard to the nature of the vegetation which clothed the land that represented North America during the Cretaceous period. Previous to that time large collections of fossils had been made from rocks of that age on the Atlantic and Gulf coasts, but the beds which furnished them were marine sediments, and the fossils they contained were principally molluscs and radiates, but included also fragments of skeletons of Cretaceous saurians, *Mosasaurus*, *Hadrosaurus*, etc., and teeth of *Ptychodus*, a Selachian fish. In these remains there was found a generic correspondence with those of the middle and upper Cretaceous beds

* Read April 22d, 1867. Annals of the Lyceum of Natuural History in New York, vol. ix, April, 1868.

of the Old World, and many species were recognized as the same found there. In 1855, Dr. F. V. Hayden made the second of his numerous journeys into the country bordering the upper Missouri, which have resulted in such important contributions to our knowledge of the geology of the interior of the continent. At this time he was connected as Geologist and Naturalist with an exploring party sent out by the War Department under command of Lieut. (now Gen.) G. K. Warren, Corps of Topographical Engineers, U. S. A.

In the great mass of interesting materials brought by Dr. Hayden were a number of angiospermous leaves, obtained from a red sandstone lying at the base of the Cretaceous formation at Blackbird Hill, in Nebraska. Outline sketches of some of these leaves were sent to the distinguished fossil Botanist, Prof. Oswald Heer, of Zurich, Switzerland. By him they were pronounced of Miocene age, and referred to the genera *Laurus*, *Populus*, *Liriodendron*, etc.; a narrow lanceolate leaf being considered identical with *Laurus primigenia* Ung.; a broad rounded one with *Populus Leuce* Ung., both found in the Miocene of Europe. At the same time the fossils themselves were submitted to me for examination, and regarding the so-called *Populus Leuce* as generically identical with some large rounded leaves described by Zenker from the Cretaceous sandstone of Blankenburg, Germany, I considered this florula as of Cretaceous age—confirming the conclusions of Messrs. Meek and Hayden, who on other evidence had referred the deposit from which they came to that period. The plant called *Laurus primigenia* by Prof. Heer I considered a *Salix*, and the other leaves as representing the genera *Platanus*, *Populus*, *Fagus*, *Liriodendron*, *Sassafras*, *Magnolia*, etc. Unfortunately, Prof. Heer had only sketches, and those of but part of these leaves; and while I had the specimens all before me, I had no specimens of the Cretaceous flora of Europe, but only figures and descriptions of the comparatively few leaves up to that time found in this formation by Zenker, Dr. Debey, Steihler and others. It was, therefore, quite impossible that we could then make an intelligent comparison of the two floras. The genera recognized among these plants by Prof. Heer and myself were, for the most part, living in our forests, and largely represented in the Miocene strata of Europe. It is not surprising, therefore, that Prof. Heer should have considered them of Tertiary age, and that this opinion should be shared by many others.

Soon after the discovery of these plants by Dr. Hayden, he went again to Nebraska and Kansas, accompanied by Mr. Meek, and collected from various exposures of lower Cretaceous sandstone numerous additional specimens of the same and different species. Subsequently, I went myself to the region where these were collected, and spent some years in the study of the geology of the interior of the continent, exploring a large area occupied by Cretaceous rocks in Kansas, Colorado, Arizona, New Mexico and Utah. During these explorations I obtained from the Cretaceous strata,

at a great number of localities, angiospermous leaves, consisting of some of the species obtained by Dr. Hayden, with many others, all of which are described in the report of the San Juan expedition not yet published. In numerous instances, as Dr. Hayden had done, I obtained these leaves from the sandstones overlaid by calcareous beds containing *Gryphæa Pitcheri*, *Inoceramus problematicus*, and many other unmistakable Cretaceous fossils. These leaves I found to be characteristic of the strata in which they were first discovered, and was able to obtain them at nearly every exposure which I examined. In the end, I had before me, collected by Dr. Hayden and myself, at least fifty distinct species of leaves of this character from this horizon, with fragments, scarcely sufficient for description, of perhaps as many more.

Though Mr. Meek, Dr. Hayden and myself had thus demonstrated the true position first taken by us in regard to the age of the beds which furnish these leaves, the flora they represented was so modern in its character that the European paleontologists were still unwilling to admit the possibility of its being older than Tertiary; and it was only when, in 1863, M. Marcou and Prof. Capellini made a special journey to Nebraska, and collected fossils from the same localities that had yielded them to Meek and Hayden, that the fact was admitted that this flora was really of Cretaceous age.

The plants collected by Messrs. Marcou and Capellini embraced sixteen species, which have been described by Prof. Heer in the "Memoires de la Societé Helvetique des Sciences Naturelles, 1866," viz: "*Populus litigiosa*, *P. Debeyana*, *Salix nervillosa*, *Betulites denticulata*, *Ficus primordialis*, *Platanus* (?) *Newberryana*, *Proteoides grevilliæformis*, *P. acuta*, *P. daphnogenoides*, *Aristolochites dentata*, *Andromeda Parlatorii*, *Diospyros primæva*, *Cissites insignis*, *Magnolia alternans*, *M. Capellinii* and *Liriodendron Meekii*.

It is an interesting fact that of these sixteen species but three are identical with those obtained before from the same quarries, or those collected by myself elsewhere at the same geological horizon—an illustration of the richness of the flora which they represent. My own observations prove this richness still more clearly, for, as I have said, in the outcrops of the lower Cretaceous rocks of the West I have detected at least a hundred species of conifers and angiospermous trees. Of these it rarely happened, that in the chance exposure of a cliff or water-washed surface, anything like a perfect specimen could be detached and brought away. As a consequence we have, in the figures and descriptions now published or prepared, but a very imperfect view of the flora of the Cretaceous period on this continent, even as it has been exhibited to my eyes; and there is every reason to believe that but a small proportion of its elements have as yet been observed at all.

On the western margin of the continent it is well known that the Cretaceous strata are quite largely developed, having been recognized in Sonora, California, Oregon, Washington Territory

and Vancouver's Island. From the latter locality quite a number of fossil plants have been collected, which have been described by Prof. Heer, Mr. Lesquereux or myself. The first knowledge which we obtained of the Cretaceous beds of Vancouver's Island was derived from the descriptions by Mr. Meek (Transactions of the Albany Institute, vol. iv, p. 37) of some fossil molluscs collected by Dr. Turner. Subsequently, in 1858, the collections made by the United States Northwest Boundary Commission were placed in my hands for examination. These included fossil plants from the coal beds of Nanaimo, Vancouver's Island, which were associated with *Inoceramus*, *Pholadomya*, etc., before described by Mr. Meek, and which plainly indicated their Cretaceous age. These plants were described by the writer in 1863 (Boston Journal of Natural History, vol. vii, No. 4). Previous to that time the fossil plants collected by Dr. Evans, United States Geologist for the Territory of Oregon, were committed to Mr. L. Lesquereux, the well-known Botanist, who published descriptions of them in the American Journal of Science. Of these the following were from Nanaimo, viz:

Populus rhomboidea Lesqx., *Quercus Benzoin* Lesqx., *Quercus multinervis* Lesqx., *Quercus platinervis* Lesqx., *Salix Islandicus* Lesqx., *Cinnamomum Heerii* Lesqx., *Ficus sp.* Lesqx., with which are enumerated, but not described in full, "a *Platanus* with the same nervation as *Quercus platinervis*," a *Chamærops* agreeing with *Sabal Lamanonis* Bergh., common in the European Miocene, a very fine *Salisburia*, very variable in the outline of its leaves, and named *Salisburia polymorpha*, also a small piece of a fern referable to the genus *Lastrea*, and a *Sequoia* probably identical with *S. sempervirens*.

The Bellingham Bay plants described by Mr. Lesquereux consisted of species of *Smilax*, *Quercus*, *Planera*, *Cinnamomum*, *Persoonia*, *Diospyros* and *Acer*. By Mr. Lesquereux the plant-bearing strata of Bellingham Bay and Vancouver's Island were regarded as of the same age, and from the resemblance of the species they contain to those found in the Miocene of Europe, he pronounced them to be of that date (op. cit., vol. xxvii, p. 362). In a subsequent number of the American Journal of Science (vol. xxviii, p. 85) is published a letter from Prof. Heer upon these plants, of which sketches had been sent him by Mr. Lesquereux. In these notes the extinct flora of Vancouver's Island and Bellingham Bay are considered of the same age, and brought still nearer the Miocene of Europe; quite a number of species being regarded as identical with those found at Oeningen, etc.

Since that time a collection of fossil plants made by Dr. C. B. Wood at Nanaimo, V. I., and at Buzzard's Inlet, British Columbia, was sent by Dr. Hooker to Prof. Heer for examination. From the coal mine at Nanaimo but a single species of this collection was obtained—a conifer, considered by Prof. Heer as identical with *Sequoia Langsdorfii* Br. sp., a species common in the Miocene of Europe. From these facts it will be seen that the modern aspect

of the fossil flora of Vancouver's Island has produced the same misapprehensions as the Cretaceous flora of Nebraska. This, however, is not to be wondered at, and conveys no reproach to the eminent scientific men who have been misled by it. The identification of species by few and fragmentary specimens, or still worse by sketches, is a difficult and hazardous task for any one to perform; and in regard to the generic relations of the plants described, it can only be said, that previous to the discovery of such modern genera as *Liriodendron*, *Magnolia*, *Sassafras*, etc., in the Cretaceous rocks, they were naturally regarded as belonging to the present or Tertiary flora. It is also true that the flora of the Cretaceous period in the Old World has until recently been considered, from the number of Cycads it includes, as a continuation of the Jurassic flora; and it contains East Indian forms, none of which have as yet been discovered on this continent. There is no more doubt, however, that the plant-bearing strata of Vancouver's Island are Cretaceous than in regard to those of Nebraska. A very large number of Cretaceous molluscs have been collected, both in the overlying beds and those containing the plants, as was stated by the writer in 1863, in the report on the fossils collected by the Boundary Commission.

As regards the strata containing the plants and coal of Bellingham Bay, further observations and collections must be made there before the question can be said to be definitely settled. Mr. Gabb, paleontologist to the California geological survey, who has recently visited Bellingham Bay, has been led by the molluscous fossils obtained there to consider all the coal-bearing series of that district as Cretaceous. If this be so, there has been some error in the labeling of specimens which have come into my hands professedly from "Bellingham Bay." Some of them are unquestionably Miocene, for they include *Glyptostrobus Europæus*, *Taxodium occidentale*, and other plants found in the Miocene strata of Dacotah and Montana. The truth probably is that both formations are represented at or near Bellingham Bay. The coal of Goose Bay and the fossiliferous strata at Astoria are known to be Miocene, as are also the plant-bearing beds at Birch Bay and Buzzard's Inlet, and I have lately received a beautiful collection of Miocene plants from a locality not far distant in the interior.

From Orcas Island, which occupies an intermediate position between Bellingham Bay and Vancouver's Island, a collection of plants was made by Mr. George Gibbs of the Boundary Commission, in which the species are, with perhaps one exception, different from those obtained from the other two localities mentioned. These include ferns, palms and broad-leaved plants described in the report to which I have alluded, where they are referred to the Cretaceous period.

Combining the contributions thus made to our knowledge of the Cretaceous flora, and referring to this formation all that we now know to belong there, we have the following list of genera and species:

N. A. Cretaceous Plants now or hitherto described.

Populus rhomboidea *Lesqx.* Nanaimo.
Salix Islandica *Lesqx.*, "
Quercus Benzoin *Lesqx*, "
Quercus multinervis *Lesqx.*, "
Quercus platinervis *Lesqx.*, "
Cinnamomum Heerii *Lesqx.*, "
Salisburia polymorpha *Lesqx.*, "
Aspidium Kennerlii *Newb.*, "
Sabal sp., *Newb.*, "
Taxodium cuneatum *Newb.*, "
Ficus (?) cuneatus *Newb.*, Orcas Is.
Tæniopteris Gibbsii *Newb.*, "
Sphenopteris (Asplenium) elongata *Newb.*, Orcas Is.
Populus Debeyana *Heer*, Nebraska.
P. litigiosa *Heer*, "
Salix nervillosa *Heer*, "
Platanus Newberryana *Heer*, "
Andromeda Parlatorii *Heer*, "
Diospyros primæva *Heer*, "
Phyllites Vannonæ *Heer*, "
Aristolochites dentata *Heer*, "
Cissites insignis *Heer*, "
Ficus primordialis *Heer*, "
Magnolia alternans *Heer*, "
M. Capellinii *Heer*, "
Liriodendron Meekii *Heer*, "
Betulites denticulata *Heer*, "
Proteoides daphnogenoides *Heer*, Nebr.
P. acuta *Heer*, Nebraska.
P. grevilliæformis *Heer*, "
Leguminosites Marcouanus *Heer*, Nebr.
Sapotacites Haydenii *Heer*, Nebraska.
Populus cyclophylla *Heer*, "
Phyllites obcordatus *Heer*, "
Sassafras cretaceum *Newb.*, "
Liriodendron primævum *Newb.*, "
Araucaria spatulata *Newb.*, "
Quercus salicifolia *Newb.*, "
Magnolia rotundifolia *Newb.*, "
Platanus latiloba *Newb.*, "
Fagus cretacea *Newb.*, "
Sphenopteris corrugata *Newb.*, "
Pyrus (?) cretacea *Newb.*, "
Populus elliptica *Newb.*, "
P. microphylla *Newb.*, "
P. cordifolia *Newb.*, "
Acerites pristinus *Newb.*, "
Alnites grandifolia *Newb.*, "
Salix flexuosa *Newb.*, "
S. cuneata *Newb.*, "
S. membranacea *Newb.*, "
Quercus antiqua *Newb.*, S. Utah.
Quercus sinuata *Newb.*, "
Cupressites Cookii *Newb.*, New Jersey.

From this list it will be seen that the Cretaceous strata of the west coast include some forms not yet discovered in the Kansas and Nebraska beds. Among these, *Salisburia*, *Sabal*, *Cinnamomum*, etc., are indicative of a warmer climate. Possibly these genera may hereafter be detected in the plant-beds of Kansas, Nebraska and New Mexico, but as yet we have no intimation of their existence, and there is nothing now known in the Cretaceous flora of that region which gives it a tropical or even sub-tropical character.

It will be remembered that this vegetation grew upon a broad continental surface, of which the central portion was considerably elevated. This would give us physical conditions not unlike those of the continent at the present day; and it would seem to be inevitable that the isothermal lines should be curved over the surface somewhat as at present. It may very well happen, therefore, that we shall find the palms and cinnamons restricted to the western margin of the Cretaceous continent. It will be seen by the notes now given of the Tertiary flora of our continent, that, at a later date, palms grew in the same region where these Cretaceous plants are found; but cinnamons and other tropical plants seem to be entirely wanting in the Tertiary flora of the central part of the continent, while on the west coast both palms and cinnamons lived during the Tertiary period as far north as the British line. We have therefore negative evidence from the facts, though it may be reversed at an early day by further observations, that the climate

of the interior of our continent during the Tertiary age was somewhat warmer than at the beginning of the Cretaceous period, and that during both, the same relative differences of climate prevailed between the central and western portions that exist at the present day.

3. *On Human remains along with those of the Mastodon in the drift of California;* by Dr. C. F. WINSLOW.—Dr. Winslow, in a letter dated Baden Baden, Sept. 24, 1868, has called our attention to the following paragraphs in the Proceedings of the Boston Society of Natural History for 1857, p. 278, taken from a letter of his presented to the Society at the meeting of October 7, 1857 (11 years since), along with a fragment of the human cranium referred to. Dr. Winslow writes: "I sent by a friend, who was going to Boston this morning, a precious relic of the human race of earlier times, found recently in California, 180 feet below the surface of Table Mountain. As it is the first organic sign of human existence preceding or coëval with a drift age, or a general or minor 'deluge,' that has been found in the earth, I have thought it would be interesting for the scientific gentlemen of Boston to discuss the subject, and for a portion of the fragment sent to me to be preserved in the cabinet of your Society of Natural History. My friend Col. Hubbs, whose gold-claims in the mountains seem to have given him much knowledge of this singular locality, writes that the fragment was brought up in 'pay dirt' (the miners' name for the placer gold drift) of the Columbia claim, and that the various strata passed through in sinking the shaft consist of volcanic formations entirely. Whether his knowledge is accurate touching the volcanic formations I have some doubt, and have written for more certain information.

"The mastodon's bones being found in the same deposits, points very clearly to the probability of the appearance of the human race, on the western portions of North America at least, before the extinction of those huge creatures. As I have fragments of *Mastodon* and *Elephas primigenius*, or a kindred species, taken between ten and twenty feet below the surface, among the upper placer gold deposits of the same vicinity, it would seem that man was probably contemporary, for a certain period, with the closing dynasties of these two formidable races of quadrupeds. This discovery of human and mastodon remains in the same locality gives also great strength to the possible truth of the old Indian tradition of the contemporary existence of the mammoth and aboriginals of this region of the globe."

Dr. Winslow states in his letter from Baden Baden that this discovery was made in 1855. He adds also: "I have a fragment of a gigantic bone which Leidy examined and wrote me that it belonged to an extinct Sloth. It came from beneath the most populous part of the city, 30 feet, perhaps, below the surface. Another smaller, from another locality outside the city west, which he also pronounced as a Sloth, extinct and undescribed. I took fragments of trees and serpentine stones bored by *Lithodomi*, lying

pell-mell together from 60 to 90 feet below the surface in a tunnel not far from the western shore of the peninsula."

4. *Meek on the shell structure of some Spirifera.*—Mr. Meek's paper on this subject, referred to on p. 262, was read before the Academy of Natural Sciences of Philadelphia in December, 1865, and published in the Proceedings of the Academy, February, 1866.

III. BOTANY AND ZOOLOGY.

1. *Botanical Notices.*—Two new parts (containing three fasciculi) of the *Flora Brasiliensis* of von Martius have been issued during the past summer. The most considerable is fasc. 44, containing the *Loranthaceæ*, the work of the indefatigable Eichler, 134 pages of letter press and 44 plates, all the analyses by Eichler himself. The Brazilian *Lorantheæ* are all referred to *Psittacanthus* of Martius, a genus of undoubted character, and four others, two of them long ago proposed by Martius, which are conceded to be less distinct from *Loranthus*. The *Visceæ* of Brazil comprise 33 species of *Phoradendron*, an *Ixidium*, this being a genus founded by Eichler on one Brazilian species and the Cuban *Eremolepis Wrightii* of Grisebach, and an *Eubrachion*. In a note we have a synopsis of Eichler's West Indian genus *Dendrophthora* (*Arcenthobia* of Grisebach) 6 species. Fasc. 45 contains the *Loganiaceæ* by Dr. Progel, a new collaborator; seven genera, of which only *Spigelia* and *Strychnos* are rich in species; 16 plates; also the *Oleaceæ* and *Jasmineæ* by Eichler, with three plates. The *Chionantheæ* are still said to have "semina exalbuminosa," which, as we have long ago indicated, is not the case in the original *Chionanthus*. In fasc. 46, Dr. Seubert describes the *Styracaceæ*, two species of *Pamphilia* and 22 of *Styrax*, illustrated by five plates.

DeCandolle's Prodromus, vol. xvi, section 2, fasc. 2, issued in June last (500 pages), contains the *Betulaceæ* by Regel; the *Salicineæ* by Anderson, except the Poplars which are by Wesmael; the *Casuarineæ* by Miquel; the *Gnetaceæ* and the *Coniferæ* by Parlatore; and the *Cycadaceæ* by A. DeCandolle himself; to which are added the *Resedaceæ*, by T. Müller; and the *Lacistemeæ*, *Gunnereæ*, *Ancistrocladeæ*, *Dipterocarpeæ*, *Lophiraceæ*, *Monimiaceæ*, *Helwingiaceæ*, &c., by the editor. This important volume, especially as to the *Coniferæ*, opens a wide range for commentary, upon which we may not here enter.

No. 2 of the 12th volume of the 7th series of the Memoirs of the Imperial Academy of Sciences of St. Petersburgh (1868) is occupied by Fr. Schmidt's *Riesen in Amur-lande und auf der Insel Sachalin*, the botanical part, with two maps and eight plates. The plants collected in Amur-land and on the way to Sachalin (nearly 500 species) are first enumerated; and this is followed by the still more interesting *Flora Sachalinensis*. Noting the points most remarkable as respects the relations of this flora with that of the United States, we observe that the Japan *Trautvetteria* is kept distinct from the North American; *Diphylleia Grayi* from *D. cymosa;*

Caulophyllum robustum from *C. thalictroides; Vitis Thunbergii* from *V. Labrusca* (for which a good diagnosis, not yet published, has recently been made out by Prof. Braun); *Pyrus sumbucifolia* is said to have larger fruit than *P. Aucuparia*, which also occurs in the islands; *Phellopterus littoralis* is adopted in place of *Glehnia littoralis* for the plant called *Cymopterus? littoralis;* a new *Stenanthium* is described and figured, &c. *Ehrharta caudata* of Monro, rediscovered in Sachalin, becomes the type of a new genus *Brylkinia.* A. G.

2. *Contributions to the Fauna of the Gulf Stream at great depths;* by L. F. DE POURTALES, Assist. U. S. Coast Survey, (from the Bulletin of the Mus. Comp. Zoöl., Cambridge).—The author introduces his paper, describing the species observed by him, with the following remarks.

The study of the constitution and of the inhabitants of the bottom of the sea is a field of research which has attracted the attention of naturalists in comparatively recent times. What Humboldt did with regard to the distribution of life at different heights in the atmosphere, was done by Edward Forbes for the different depths of the ocean. The former's diagrams of the zones of vegetation on the slopes of the Andes are considered indispensable in every atlas of physical geography. But what one man could do where his glance embraced miles of country in height and breadth and where the type of vegetation could frequently be recognized as far as the eye could reach, an investigator even as zealous as Forbes could but sketch in broad though happily drawn lines for the marine animals.

Much has been done in this direction since Forbes's death, particularly in England, where dredging has become a favorite occupation of many naturalists; the Scandinavian seas have also been explored with much success, chiefly by the Norwegian naturalists; but much more remains to be done in a field in which the areas to be explored can, as Jeffreys remarks, be reckoned in square degrees, whilst the research extends only over several square yards.

It is particularly in the greater depths, in the so-called abyssal region, that our knowledge is deficient. This is easily understood, since on many coasts the sea is comparatively shoal for a considerable distance from land, and the outfit for deep sea dredging is beyond the means of but few private individuals. Government expeditions are generally fitted out for other duties, and can rarely devote their time to operations occasioning a delay of many hours. Furthermore, owing to the scantiness of the material, the impression generally prevailed, until recently, that animal life was soon reduced to a minimum with an increase of depth, or at least reduced to the lowest forms, so that the incentive of a rich harvest seemed denied to those who would have undertaken such researches.

Excepting the investigations of Dr. Stimpson on the coast of New England, the dredge has been as yet very little used along our shores. The character and constituents of the bottom are

however pretty well known, thanks to the care of the late Superintendent of the Coast Survey, Professor A. D. Bache, who, during his whole administration of that work, required the hydrographical parties to preserve the specimens brought up by the lead. From eight to nine thousand specimens have thus been accumulated at the coast survey office, from a region comprised between the shore and the outer edge of the Gulf Stream, and reaching nearly to 1500 fathoms. But, of course, aside from the Foraminifera and Diatomaceæ, for the study of which this material has proved of high interest, not much was contributed to our knowledge of the animals of the higher classes, the instrument used being only adapted to procure a small quantity of sand or mud.

The present Superintendent of the Coast Survey, Professor B. Peirce, has lately directed the resumption of the investigations of the Gulf Stream, so successfully inaugurated by his predecessor, but interrupted for several years by the war. Besides observations of the depth, velocity, and direction of that current, and the temperature and density of the water at different depths, the researches will be extended to the Fauna of the bottom, of the surface, and of the intervening depths. Not only will an insight be thus obtained into a world scarcely known heretofore, but that knowledge will have a direct bearing on many of the phenomena of that great current. Thus a new light may be thrown on its powers of transportation from shallow to deeper water, or along its bed, on its action in forming deposits in particular localities, or on its possible influence on the growth of coral reefs on its shores.

The first campaign on this plan was organized in 1867, the field of research being in a section between Key West and Havana, incidentally with the purpose of sounding out the line for the telegraph cable, shortly afterwards laid between these two points. The Coast Survey steamer Corwin was assigned to the work; and here I wish to express my thanks to my colleague, Assistant H. Mitchell, charged with the physical part of the campaign, and to Captain Platt and his officers for the interest they showed in my work, and for their valuable practical aid.

The expedition was unfortunately interrupted by the breaking out of yellow fever on board, so that the dredgings were few in number. However, short as the season's work was, and few as were the casts of the dredge, the highly interesting fact was disclosed, that *animal life exists at great depths, in as great diversity and as great an abundance as in shallow water.*

The identifications of the species has been made by me at the Museum of Comparative Zoölogy at Cambridge, in the rich collections of which I have found abundant material for comparison; facilities of every sort were afforded me by Professor Agassiz, for which I wish to express my heartfelt thanks, as also for this opportunity of prompt publication.

The first dredgings were made on May 17th, on the Florida side

of the Gulf Stream, about 5 miles S.S.W. of Sand Key, in depths varying from 90 to 100 fathoms, on a bottom of calcareous mud. The following list comprises the animals obtained:—

Articulates.—A number of small Crustacea were brought up, which have not yet been determined. They belong to the following or allied genera; *Dromia*, *Ilia*, *Mithrax?* (a mutilated specimen), *Pagurus*, *Euphausia*, and *Orchestia*.

The tubes of several species of Annelids were obtained, but the animals were in most cases too defective for identification. The largest and best preserved is *Morphysa floridana*, nov. sp. (see description). There are also tubes of one or more species of *Serpula*.

The Gephyreans are represented by *Sipunculus corallicola*, Pourt. (Proc. Am. Assoc., 1851.)

Molluscs not determined specifically. These are mostly immature specimens or fragments of dead shells, and belong to the following genera: *Murex* (dead), *Turbo?* (operculum), *Leda* (living), *Astarte* (living), *Tellina* (dead). Of Pteropods dead shells of the following species: *Hyalea tridentata*, *Hyalea trispinosa*, *Cuvieria columella*, *Cleodora lanceolata*. The shells of this order are very common in deep-sea soundings. The Bryozoa are represented by *Vincularia margaritacea*, nov. sp. (see description).

Radiata.—Of Echinoderms were obtained an *Ophiurian* (an arm, undetermined) and a number of specimens of *Comatula Hagenii*, nov. sp. (see description).

A *Zoanthus*, rather small, was obtained also, but not having been noticed when alive, it would be somewhat uncertain to determine.

Hydroids: *Antennularia triseriata*, nov. sp.; *Thoa pulchella*, nov. sp.; *Th. capillaris*, nov. sp. (see descriptions).

The Foraminifera had nearly all been washed out of the dredge; only the following were noticed: *Textilaria conica* D'O. (very large); *Operculina* (*Spirillina*) *incerta* D'O.; *Rotalina cultrata* D'O.; and *Globigerina rubra* D'O.

The total for this locality is therefore twenty-nine species, to which a few ought to be added for the undetermined fragments of Annelids.

No dredgings were had in mid-channel; this part has been reserved for the return trip, but the unfortunate interruption of the cruise prevented the execution of the project, at least for this season.

The next casts were obtained off Havana in 270 fathoms on May 24th and 29th, on both days as nearly as possible on the same spot, as the little that was obtained at the first date had given much promise.

The results of the two casts are combined below:—

Articulates.—The Crustacea are not determined, but are of or near the following genera: *Stenopus*, *Axia*, *Callianassa*, *Orchestia*, and *Idotea*, all living. Annelids: *Marphysa tibiana*, n. sp., and *M. antipathum*, n. sp. (see description). Tubes and fragments of four or five other species.

Of the *Molluscs* the Gasteropods and Acephala have not yet been determined, with one exception.

The following genera are represented: *Mitra?*, *Fusus*, *Turbo*, *Emarginulina*, *Dentalium*, *Nucula*, and *Spondylus*, all dead; *Pedicularia decussata*, Gould (see remarks), and a very small *Anomia*, both living. The Pteropods and Heteropods were all dead; they are: *Hyalea trispinosa*, *affinis* D'Orb., *gibbosa* Rang, and *uncinata* Rang; *Creseis spinifera* Rang; *Cleodora pyramidata* Pér. and Les.; *Spirialis rostrata* Eyd. and Soul.; and *Atlanta Peronii* Les. Of Brachiopods we obtained *Terebratula Cubensis*, n. sp., and *Terebratulina Cailleti* Crosse; both living and apparently abundant. The Bryozoa are: *Farcimia cereus*, n. sp.; *Vincularia margaritacea*, n. sp.; *Cellepora reticulata*, n. sp.; *C. sigillata*, n. sp.; *Canda retiformis*, n. sp.; *Canda cornigera*, n. sp., *Idmonea flexuosa*, n. sp. (see descriptions).

Radiata.—Echinoderms are represented by the following species; *Spatangus* (dead, fragments); *Fibularia* (dead); *Cidaris annulosa* Gray (probably, young, living); *Tripneustes ventricosus* (living, very young); *Asterias*, sp. (very young, living); *Ophiurians*, at least three species immature and difficult to determine; *Comatula brevipinna* n. sp., living; *Pentacrinus*, sp. (fragments of stem, among which some appear quite fresh).

Of Zoantharia the following were brought up: *Antipathes humilis*, n. sp.; *Antipathes filix*, n. sp.; *Acanthogorgia aspera*, n. sp.; *Gorgonia exserta* Ellis; *Swiftia exserta* Duch. and Mich.; *Hyalonema* (spicules); *Caryophyllia formosa*, n. sp.; *Deltocyathus Agassizii*, n. sp.; *Stylaster complanatus*, n. sp.; *Errina glabra*, n. sp.; *Errina cochleata*, n. sp.; *Crypthelia Peircei*, n. sp.; *Distichopora sulcata*, n. sp.; *Heliopora? tubulata*, n. sp.: *Heliopora? carinata*, n. sp.; *Isis?* (base of stem); *Sarcodyction rugosum*, n. sp.

Hydroids: *Thoa pulchella*, n. sp.; *Tubularia crinis*, n. sp. Foraminifera: *Lagena striata* Mont., rare; *Nodosaria pyrula* D'O., rare; *Dentalina communis* D'O., rare; *D. (agglutinans?)*; *Lingulina carinata* D'O; *Textularia trochus* D'G., common, very large also abundant in shoaler water; *T. agglutinans* D'O., rare; *Nonionina scapha*, rare; *Nonionina umbilicatula* Montg., rare; *Cristellaria crepidula* F. and M., rather common; *Orbiculina adunca* D'O., rare and only in a worn state, its proper habitat is in the littoral zone; *Amphistegina gibbosa* D'O., rare and only young specimens; it is very common throughout the Gulf of Mexico in deep water; *Globigerina rubra* D'O., very abundant, also in the Orbulina form; *Gl. Dutertrei* D'O., common; *Pullenia obliquiloculata* P. and J., rather common; *Pullenia coarctata*, n. sp., rather common; *Sphæroidina dehiscens* P. and J., not common; *Rotalina cultrata* D'O., very common; *Rot. truncatulinoides* D'O., common; *Rot. Poeyi* D'O., rather common; *Rotalina*, two other species in single and imperfect specimens; *Biloculina*, sp.; *Triloculina Brongniartiana* D'O., rare; *Quinqueloculina bicostata* D'O., rare.

Many of the specimens of Foraminifera are filled up with a yel-

low mass, like the first stage of transformation into greensand, but the process seems to stop here.

Of sponges quite a number were obtained, at least a dozen species, which have not yet been determined. Some of the detached spicules are remarkable for their size; one, for instance, of the slender rectangulated sexradiate type of Bowerbank measuring more than half an inch.

The vegetable kingdom was represented in this dredging by a single specimen of a minute alga, *Centroceras clavulatum* Agardh., which Harvey says was found abundantly at low water mark at Key West. In its branchlets was entangled a chain of a species of *Biddulphia*. Other Diatoms are rather scarce and have not yet been determined. We therefore find here, also, a confirmation of the remark made in European seas, that vegetable life does not extend to depths as great as are reached by animals, and that, therefore, the greater number of deep-sea animals must be carnivorous.

The dredge contained also a number of nodules of a very porous limestone, similar in color and texture to the limestone forming the range of low hills along the shore of Cuba, but composed apparently of the remains of the same animals which were found living. Thus our Deltocyathus, Caryophyllia, the various Pteropods were recognized in the stone, and found also in various stages of fossilization. The interstices between the larger forms are generally filled up with Foraminifera.

On May 25th the dredge was sent down in 350 fathoms, outside of the locality occupied on the 24th and 29th. It brought up only a few dead corals: *Caryophyllia formosa*, *Deltocyathus Agassizii*, *Diplohelia profunda*, the latter in numerous specimens (see description). Also a fragment of the siliceous skeleton of a sponge, forming a regular net-work somewhat like that of Euplectella as figured by Bowerbank, but lacking the spines.

The soundings made during the cruise seem to indicate a kind of submarine terrace, on which the dredgings of the 24th and 29th were made. The cast of the 25th was probably made on the edge of it, and the dredge no doubt touched bottom only for a short time, after which the ship drifted off into water too deep for the line attached.

3. *Deep-Sea dredgings in the region of the Gulf Stream*; by L. F. Pourtales. (Communicated by the author, to one of the Editors, Sept. 30, 1868).—I sent you a few days ago a small pamphlet* containing some of the results of the deep-sea dredgings made by me in connection with the exploration of the Gulf Stream by the Coast Survey. If you think it worthy of notice in the Journal of Science, I have thought it would add to the interest to mention the much more complete results of this year's campaign, which were the subject of a brief communication I made to the late meeting of the National Academy at Northampton. As the specimens have not all been determined as yet, I can give here but a short outline.

* The article above noticed.

The dredgings were made outside of the Florida reef, at the same time as the deep-sea soundings, in lines extending from the reef to a depth of about 400 to 500 fathoms, so as to develop the figure of the bottom, its formation and fauna. Six such lines were sounded out and dredged over, in the space comprised between Sand Key and Coffin's Patches. All of them agree nearly in the following particulars; from the reef to about the hundred fathom line, four or five miles off, the bottom consists chiefly of broken shells and very few corals, and is rather barren of life. A second region extends from the neighborhood of the hundred fathom line to about 300 fathoms; the slope is very gradual, particularly between 100 and 200 fathoms; the bottom is rocky and is inhabited by quite a rich fauna. The breadth of this band varies from ten to twenty miles. The third region begins between 250 and 350 fathoms and is the great bed of Foraminifera so widely extended over the bottom of the ocean.

The second region is the most interesting, from the variety of animals inhabiting it. The bottom-rock, of which many pieces were brought up, is a limestone, still in progress of formation from the debris of the shells, corals, etc., growing and dying on its surface. In this fauna the vertebrates are only represented by a very few small fishes, and those not deeper than 100 fathoms. But all the branches of invertebrates are represented; I will mention the most characteristic. Of the Molluscs, the most common is *Terebratula Cubensis, mihi*, and a new species of *Waldheimia*, both of large size. Of the former, more than a thousand specimens, and several hundred of the latter, were collected. Gasteropods are rarer and mostly small, the largest being the *Voluta junonia*, which was obtained living several times, and dead frequently. Acephala are rather rare and small, but Bryozoa are abundant. Articulates (Crustacea and Annelids) are well represented. But the great richness of this region lies in the Radiata. Of Echinoderms, the most common is a *Cidaris* (nov. sp.), besides which there are several new species of Echinidæ and very interesting Asteridæ and Ophiuridæ. Holothuriæ are rather rare, except a new Psolus. Of corals, I have eighteen new species, belonging principally to the families of Turbinolidæ and Oculinidæ; the Eupsammidæ are also represented by two or three species, the Fungidæ (a true Fungia) and the Milleporidæ by one each. The Madreporidæ and Astræidæ are entirely absent. There are also two or three species of Antipathes, eight or nine of Gorgonidæ, several of Actinidæ, some of them very abundant, Hydroid polyps, sponges, and Foraminifera. As a general rule, every thing is of small size. There are no seaweeds. Some animal remains are found whose presence is accidental, such as sharks' teeth, bills of Cephalopods, shells of Pteropods, &c., which have evidently come from near the surface, and also a considerable number of bones of the manatee, most frequently pieces of ribs; for the occurrence of the latter I am not able to account, as the manatee does not inhabit the open sea, and there are no currents to bring the floating carcasses from its usual haunts in the shallow bays.

From the third region the dredge brought up fewer though no less interesting specimens, the chief of which is a new Crinoid, belonging to the genus *Bourgueticrinus* of D'Orbigny; it may even be the species named by him *B. Hotessieri*, which occurs fossil in a recent formation in Guadaloupe, but of which only small pieces of the stem are known. I obtained half a dozen specimens between 230 and 300 fathoms, unfortunately more or less injured by the dredge.

The deepest cast made was in 517 fathoms; it gave a very handsome Mopsea, a crab, an Ophiurian, and some annelids.

The difference of the deep-sea faunæ of the opposite coasts of Cuba and Florida is very marked, although the distance is so small; of all the corals for, instance, described by me from the coast of Cuba, only two or three, and those in fragments, were found off the Florida reef.

The descriptions of the new species, with plates, are in preparation and will be published by the kindness of Prof. Agassiz in the next number of the illustrated Catalogue of the Museum of Comparative Zoology of Cambridge.

I am glad, also, to be able to say that Prof. Peirce, Superintendent of the Coast Survey, has directed me to continue these researches during the coming winter.

4. *On the genus Lælaps;* by Edward D. Cope. (Communicated for this Journal.)—As some confusion respecting the name of this genus has arisen, it appears best to attempt to correct it at as early a day as possible. This confusion, as it appears to me, has been created by remarks contained in an essay by Dr. Joseph Leidy, published in the last number of the Proceedings of the Academy, entitled "Remarks on a jaw-fragment of Megalosaurus."

In the Transactions of the American Philosophical Society, xi, p. 143, Dr. Leidy describes a large carnivorous reptile allied to Megalosaurus, under the name of *Dinodon horridus*. He assigns to it, with some expression of doubt, teeth of two distinct forms, viz: some having a lenticular transverse section, with crenation on the two margins in part, and others having a lenticular section, truncate to a greater or less degree, in place of its angles, and therefore crenate on three edges in part.

If Dr. Leidy had left the matter undecided as to which of these he regarded as the type of the genus *Dinodon*, the almost universal practice of naturalists would refer the name to that form which should not be first thereafter discovered to be distinct and named.

I have been of the opinion that the two forms of teeth included by Dr. Leidy under the head of Dinodon really belong to distinct animals, and Leidy is also of that opinion. In 1866, in describing the genus *Lælaps* (Proc. Acad., p. 279), I said: "The genus *Lælaps* belongs to the family *Dinodontidæ*, which is characterized * * by its compressed sabre-shaped teeth. It differs * * from Dinodon in that teeth of the latter have two posterior serrate edges separated by a posterior plane." This, then, according to the usage of naturalists, establishes the name of Dinodon for the truncate teeth, and Lælaps for the two-edged.

Dr. Leidy, however, in an essay just published (Proc. Acad., 1868, p. 198), in expressing his belief in the distinctness of the two genera, states that "teeth of like shape" (i. e., like Megalosaurus), "referred by me to Dinodon, alone belong to this genus," and names the species represented by the truncate teeth, or the true *Dinodon horridus*, *Aublysodon mirandus*. He then goes on to say: "Future discovery may prove Lælaps and Dinodon identical," and on p. 199: * * "An enemy which may perhaps on nearer comparison of corresponding parts prove to be another species of the same genus, until now supposed to be different, under the names of Dinodon and Lælaps." It is thus sufficiently obvious that the proposition is to refer Lælaps as a synonym of of Dinodon. It appears to me, on the other hand, that is contrary to the rules of nomenclature, and the principles which lie at their root, and that the name *Aublysodon* is a synonym of Dinodon.

This is, however, on the supposition that Leidy had left the question open or uncertain, as to which of the two forms of teeth was characteristic of his genus *Dinodon*. I think, however, he has not left it undecided, and I am supported in this by the opinion of von Meyer.

The teeth of Lælaps, both from New Jersey and Nebraska, do not differ from those of Megalosaurus, while those of Dinodon do. It was not to be supposed that Dinodon was established on teeth of the former character, as the practice of describing species and genera, without a basis of distinctive characters, is an unusual and bad one, and ought not to be tolerated in natural science.* In describing Dinodon, Leidy says the Lælaps-like teeth resemble those of Megalosaurus, and in his recent article in the Proc. Academy (p. 198), that they are "identical in character with those of Megalosaurus."

He, however, specifies that the truncate teeth of Dinodon are really those that characterize it, in the following words: "As the entire dentition of Megalosaurus has not yet been ascertained, it may turn out to be the case that in other parts of the jaws than those known it possesses teeth like the ones *above described as peculiar*. Should, on future discovery, such a condition of things be proved to exist, *Dinodon* would then cease to be anything more than a second species of Megalosaurus." The truncate teeth are then the "peculiar" feature of Dinodon, and all that prevents the species from being referred to Megalosaurus.

Von Meyer has understood this language as I have, and has believed that the teeth now ascribed by Leidy to *Aublysodon*, are really characteristic of Dinodon. He says (Palæontographica, vii, p. 267) that while some of the teeth are identical with those of Megalosaurus, "the others indicate such peculiarity, that Leidy,

* Falconer says of it: "It assumes a difference on theoretical grounds, where the direct evidence, so far as it goes, indicates the contrary; and its general adoption would tend to arrest on the threshold the investigation of the means through which remote geographical forms, presenting common characters, may have started from a common origin.—(*Nat. Hist. Review*, 1863, p. 64.)

who has made the investigation, thought it necessary to characterize the animal as distinct from Megalosaurus, under the name of *Dinodon horridus*."

It is therefore evident that the Lælaps-like teeth described under Dinodon are really those that require a new name, if any. I will not give them a name, however, since there is no evidence that they differ from either Megalosaurus or Lælaps, though of course the probability is, that they belong to a species of the latter genus.

Although *Aublysodon* would thus be a synonym of Dinodon, it is not an altogether useless name, since the latter was given years ago to a genus of serpents by Duméril and Bibron, and may therefore be suppressed. The name of the family *Dinodontidiæ* also, which I gave in compliment to Dr. Leidy, may also be disused.

In the same way, a genus of extinct reptiles was distinguished as *Tomodon* Leidy, a name long since given to a genus of American serpents. Not liking to substitute a generic name given by another, by one of my own, I have requested Dr. Leidy to give me one by which to replace it.

The synonymy of these genera will then be

LÆLAPS Cope.

Dinodon Leidy, 1868, not of 1857.

LÆLAPS AQUILUNGUIS Cope, Proc. Ac. Nat Sci. Phil., 1866.

LÆLAPS MACROPUS Cope, sp. nov.—This species differs from the former in the relative proportions of the phalanges and tibia; the toes were relatively larger than in the preceding. Some of these bones are figured by Leidy (Cretaceous Reptiles), and described under the head of animals related to Hadrosaurus. It will be described more fully by me in my forthcoming memoir on the extinct reptiles of North America.

AUBLYSODON Leidy.

Dinodon Leidy, 1857, Proc. A. N. Sci. Phil., 1866, p. 198, not Duméril and Bibron.

AUBLYSODON HORRIDUS, *Dinodon horridus* Leidy, Trans. Amer. Philos. Soc., xi, p. 143. *Aublysodon mirandus* Leidy, Proc. Acad. Nat. Sci. Phil., 1866, 198.

5. *Considerations drawn from the study of Mole Crickets;* by SAMUEL H. SCUDDER, (from the Proceedings of the Boston Society of Natural History, vol. xi, January 22, 1868.)—Mr. S. H. Scudder stated that he had recently been studying the mole crickets with a view to their classification, and found that they were naturally divisible into two groups. For one he retained the name of *Gryllotalpa*, under which all the species had formerly been grouped, and to the other applied that of *Scapteriscus*. These two groups were separated by the following characteristics.

In *Scapteriscus* the posterior margin of the sternum of the eighth

abdominal segment of the ♂ is produced into a stout prominent central tooth; in *Gryllotalpa* the margin is entire.

The mesosternal ridge of *Gryllotalpa* is prominent, and almost equally so throughout; that of *Scapteriscus* is never prominent on the anterior half of the segment, and is often limited to the posterior half, or is even obsolescent.

The fore trochanter of *Scapteriscus* is large; the free portion almost always equals the tibial dactyl in length, and is of about the same size at the tip as at the base; that of *Gryllotalpa* is proportionally small, seldom exceeding half the length of the tibial dactyls; the form is cultrate or lenticular.

Scapteriscus is furnished with only two fore-tibial dactyls, both of which are movable; *Gryllotalpa* has two movable dactyls besides a second pair which are immovable.

With but few exceptions, the hind femora of *Scapteriscus* more than equal the pronotum in length, while in *Gryllotalpa* they are always shorter than the pronotum.

In *Gryllotalpa* the length of all the hind tarsal joints taken together seldom exceeds half the width of the pronotum, while they equal its whole width in *Scapteriscus*.

The hind tarsal claws of *Scapteriscus* are clothed with short hairs nearly to the tip; those of *Gryllotalpa* have hairs only at the base.

The tegmina of *Scapteriscus*, with but few exceptions, cover, when at rest, two-thirds of the abdomen; in *Gryllotalpa* they seldom conceal more than one-half of the abdomen.

The nervures of the middle field of the tegmina in the females of *Gryllotalpa* are distant and rather irregular, somewhat resembling those of the males; in *Scapteriscus* they are approximate, regular and straight.

The anal cerci are longer than the pronotum in *Gryllotalpa;* shorter in *Scapteriscus*.

Finally, the ninth, and sometimes the eighth abdominal segments are furnished above, in *Gryllotalpa*, with two transverse lateral rows of long hairs directed inward, as if to keep the long folded wings in place; these are absent from *Scapteriscus*, where the wings are equally long and similarly folded.

Only one species of *Scapteriscus* has been found without the limits of South and Central America, and that—occurring in a single instance in Europe—must undoubtedly be considered an emigrant from the same warm regions; the members of the genus *Gryllotalpa*, on the contrary, are found throughout the whole world, not excluding Central and South America.

Comparing these two genera with their nearest allies, *Tridactylus*, *Cylindrodes*, etc., we find great and striking differences—differences which are extraordinary compared with those which divide *Scapteriscus* and *Gryllotalpa;* the comparatively simple fore tibia, and the abnormal appendages which supplant the hind tarsi in *Tridactylus*—the abbreviated legs fitting into cavities in the body, and the absence of articulated appendages at the extremity of the abdomen in *Cylindrodes*—these characteristics are far more

important than the sexual sculpture of the abdomen, the ultimate neuration of the tegmina, the length of the legs, the contour of the trochanters, or the digitation of the tibiæ, which separate *Scapteriscus* and *Gryllotalpa*.

The facts cited above present two features which bear upon the question of the origin of species.

First: these little mole crickets, so unique in their structure as to be widely separated from their nearest allies, are spread uniformly over the whole surface of the globe; but few species occur in any one place, and at least one is found in every temperate or hot region.

Now, if species originate or change from physical causes, or by "Natural Selection," why is it that under every physical condition and surrounded by every variety of antagonism possible in their habitat, this same unique structural form has sprung up all over the globe?

Again, how can such theories account for another feature—common, indeed, to all natural groups—that it is not one striking characteristic which separates *Scapteriscus* and *Gryllotalpa*, and which "Natural Selection" might have seized upon, with reference to some special benefit, but a combination of features which have no apparent dependence upon each other, correlated, but not necessarily connected? Why should "Natural Selection," altering for its own purpose the palm of the four-fingered mole cricket into that of the two-fingered species in South America; or, developing in South America, from some previous synthetic form of mole cricket, both the present four-fingered and two-fingered species, and in other parts of the world the four-fingered species only—destroying at the same time the primæval form all over the surface of the globe—at the same time, place rows of hairs on the hinder part of the abdomen of the tetradactylate group, and none on that of the didactylate? or make the veins of the tegmina of the ♀ of one group, distant and irregular, and those of the other straight and approximate? Why furnish the eighth abdominal segment of the ♂ of one with a projecting tooth, and deprive those of the others of such a prominence? Why give one long and the other short anal cerci, or clothe the hind tarsal nails of one with short hairs and leave the other naked? What have these features to do with the differences of structure we have mentioned in the palm-shaped fore leg, or in the length of the hind leg? These and similar difficulties, arising on every hand, seem to attend every derivative theory of the origin of species.

6. *Remarks on two new fossil Insects from the Carboniferous Formation in America;* by S. H. Scudder, (ib., Feb. 26.)—Mr. Scudder exhibited two fossil insects from the coal measures. One was found in the iron-stone nodules of Morris, Illinois, which have previously afforded remains of insects. The fragment represents the wing—apparently an upper one—of a neuropterous insect, which he called *Megathentomum pustulatum*. It is gigantic in size, very broad, with distant nervures, simple and slight divarications, and in the outer half of the wing, which alone is preserved, a cross

neuration, composed of most delicate and irregular veinlets. The wing is also furnished with a large number of larger and smaller discolored spots, the surfaces of the larger ones irregularly elevated.

The *vena mediastina* is simple and straight; the *vena scapularis* sends out two branches from its upper side, the first of which does not reach the border but loses itself in a congeries of minute veins, while the second, branching again quite near its origin, supports the tip of the wing; the *vena externo-media* occupies the middle third of the wing, and divides once near the base; each branch is straight and forks again, the upper one a little nearer the border than the second divarication of the *vena scapularis*, the lower still nearer to the margin; the *vena interno-media* divides several times, the uppermost branches forking again just inside of the border; the *vena analis* does not appear on the fragment.

There are six larger round or squarish spots; four of them form a bent row a little beyond the middle of the wing, the upper three spots being nearly straight and the lower one turned inward at a little more than a right angle; the uppermost spot occurs in the interspace between the *venæ scapularis* and *externo-media;* the others follow in succeeding interspaces. The two other large spots are found in the same interspaces with the upper two of the inner row, and are situated about half way between them and the border. The smaller spots appear to be less regularly distributed; they are usually round, but sometimes oval or elongated; there are three at equal distances from each other in the lower outer interspace formed by the branches of the *vena scapularis*, one occurs just within and above the inner of the three just mentioned, and one near the angle of the last divarication of the *vena scapularis*; there are two between the forks of the upper branch of the same, and, in the interspace between the branches one spot is found close to the margin; two larger and elongated spots occur in the same interspace with the lowest of the four large spots and three equidistant round ones in the next interspace below; in the succeeding interspace, probably about half way between the base and the outer border, there is an oval spot; finally two faint ones are situated upon and beneath each of the branches of the *vena externo-media* near the middle of the wing.

The wing was probably a little more than three inches in length; its greatest breadth measured by a line at right angles to the costal border is 1·8 inch; from the apex of the wing, where the upper branch of the *vena scapularis* touches it, to the lowest point of the lower outer angle 2·1 inches; from the center of the upper, inner large spot to the outer margin 1·05 inches; greatest breadth of an interspace, ·34. This insect, apparently allied to the *Coniopterygidæ* by the simplicity of its neuration, differs from that family, not only in the cross-veining, but in the mode of branching and the proportion of the wing allotted to each of the veins. Dr. Hagen has shown me in this wing some resemblances to the *Phryganidæ*, but I am inclined to believe it is distinct in its family characteristics from any known type of Neuroptera.

The second insect, for which the name of *Archegogryllus priscus* is proposed, was found by Dr. J. S. Newberry in the lowest coal beds at Tallmadge, Ohio. In consists of a broken leg of a cricket and a very small fragment of its wing—apparently a lower one. There are no determinate characters in the wing. The leg was broken into fragments from which a femur and tibia could be made out; they are quite remarkable, for while the femur is smooth, the tibia is furnished with several prominences of large size; in modern types, the prominences, if they occur at all, are found only on the femur; in this specimen there is a slight rounded prominence on the upper surface at the very base of the tibia and another just beyond the middle; opposite the latter, on the upper surface, is a deeply bifid elevation, its hollow corresponding to the elevation on the upper surface; the basal half of the under surface is occupied by a very broad prominence, abrupt at its edges, of nearly equal height throughout, but slightly depressed in the middle. Length of the femur, ·28 inches; breadth of the same, ·11 inches; length of the tibia, ·26 inches; breadth of the same, ·045 inches.

7. *Siredon a stage in the development of Amblystoma;* by B. Silliman.—Prof. Marsh has given on pp. 364–374 an interesting account of the transformation of *Siredon* into *Amblystoma*, illustrated by excellent figures.

The very limited time at our command at Como station, did not allow any opportunity to study the habits and actual condition of this remarkable and ambiguous reptile in its native habitat. All the metamorphoses described so clearly by Prof. Marsh occurred, it will be observed, subsequently to the removal of the collection of specimens made for us by the kindness of Supt. Snyder, to lower and warmer altitudes. This has led to some discussion of the question whether these changes in the animal would have occurred had these creatures remained in Lake Como.

On the return of our party from the terminus of the Union Pacific Railroad to Cheyenne, 120 miles east of Como, I left the party for a detour to the Colorado mines. This gave me an opportunity to see, in the possession of a person who had a sort of menagerie at Cheyenne, a number of *Amblystoma* which had been developed in the establishment from *Siredon*. These were living in a large glass fish-globe, and the proprietor assured me he had obtained them some weeks previously from Lake Como, and that when they arrived they were all in the "fish state"—much larger than at present and provided with 'gills,' as he expressed it, about the head. In a short time they commenced to change, and in about three weeks all were completely developed into Salamanders. They were six or eight in number, and when I saw them, they very closely resembled the specimens now in New Haven, and described by Prof. Marsh, with a like diversity of color and markings. I was quite particular in my inquiries of the owner, and am persuaded his account was entirely truthful, and he assured me we should find our specimens soon changing in the same manner. As this transformation was then unknown to me, and seemed very im-

probable, I received the statements with a measure of incredulity. More than three weeks elapsed before I again heard of our New Haven colony of Siredons, and I was not a little interested to learn, on my return here, that nearly the whole number had already undergone the transformation into *Amblystoma.*

We know, therefore, in the case of two different colonies of Siredons from the same locality, placed under very unlike conditions of elevation above the sea, but otherwise similarly situated, that both have undergone the same transformations. We cannot therefore avoid the conclusion that *Siredon* is a stage in the development of *Amblystoma.*

New Haven, Nov. 2d, 1868.

IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Earthquake of Aug. 13th—16th*, 1868.—We condense from newspaper accounts written immediately after the event and before accurate reports from distant points could be received, such a statement as we are able to make of the chief facts of scientific interest connected with this extraordinary convulsion of the earth. In extent and violence, as well as in destructiveness to life and property, it appears to have been one of the most remarkable experienced in South America since its settlement by Europeans. The whole western coast from New Granada to Chili was shaken, and cities and towns in great numbers were suddenly laid in ruins, either by the violence of the shocks, or by the subsequent influx of the sea, or by both. The loss of life is but imperfectly known, the estimates ranging from 30 to 60 thousand and upwards; some statements making it over 40,000 in Ecuador alone, where it was proportionally greatest on account of the first shocks occurring in the dead of night, while in other regions they took place for the most part in the daytime.

The shocks commenced on the 13th of August, about 5 o'clock P. M., and were felt throughout the coast provinces of Peru and Bolivia, the center of disturbance being in southern Peru. In different places the shocks lasted from two to seven minutes. The sea immediately retired to great distances, and returned on the coast at the rate of ten miles an hour, and with a wave full fifty feet high, that covered many towns and swept away in its reflux every thing within its power, leaving ships high and dry upon the land. The places where the convulsion was felt most severely are Arequipa about forty miles from the coast, and Moquegua about twenty-five miles inland. Arequipa, a city of fifty thousand inhabitants, situated but 14 miles from the lofty volcano called "Misti," was almost totally destroyed. Though solidly built of stone, not a church is left standing, not a house is habitable, nor scarcely one stone left upon another. Some two hundred of the inhabitants perished, the rest having had time to escape.

At this place the earthquake commenced with an undulating movement, and as the shocks culminated no one could keep his feet; the houses rocked like ships in the trough of the sea, and

came crumbling down. Nineteen minor shocks took place the same night, and the earth continued to be disturbed for some days. Openings occurred in the plains around the city, and water made its appearance in various places. The neighborhoods of Tiabaya and Sanbandia and all the outlets of the city shared her fate. The neighboring volcano opened on the side toward the north, and threw forth earth and ashes; the water which the inhabitants used to drink turned black, and of an insupportable taste.

Another important city almost totally destroyed was Iquique, in southern Peru. A correspondent of the New York Times writes:—"A few minutes after 5 P. M., on the 13th inst., the inhabitants were terrified by loud subterranean noises, presaging the approach of an earthquake. The shock immediately followed. Every building was shaken to its foundation. The population rushed into the streets, and those who were not buried by the falling walls made their escape into the country with all speed. Had they remained in the city the entire population must have perished, as immediately on the passing of the first shock, the sea retired for some distance, and then returned with a great rush and a roaring sound more terrible than the loudest thunder. The wave was of dreadful height and force, and it swept irresistibly over the town, completing the ruin begun by the earthquake. Not a mercantile establishment has escaped, nor does a vestige remain of the most opulent and handsome section of the town. The massive buildings belonging to the nitrate merchants, mostly constructed of stone and lime, have entirely disappeared. Buildings constructed of timber were swept away at once, leaving nothing to mark the place where they stood.

"The inroad made by the sea extended to the Pantera, part of which was covered by the wave, and that section of the town known by the name of the Puntella has been entirely destroyed, leaving nothing but the debris of innumerable houses.

"It is supposed that over 200 persons were killed by the earthquake."

Repeated shocks were felt subsequently to the 13th, although of a milder nature.

The establishment of the Tarapaca Nitrate Company at Molle, eight miles south of Iquique, has entirely disappeared, and other works in the nitrate districts have suffered materially. The works of the Peruvian Mining Company of London are entirely destroyed, upwards of 400 tons of silver ore, heavy machinery, and large quantities of quicksilver having been swept away like so much chaff.

In like manner Arica in Peru, the chief port for the commerce of Bolivia, after being destroyed by the earthquake, was obliterated by the sea. Of five ships that lay at anchor in the bay, all but one were destroyed with the entire or greater portion of their crews. The single exception was the United States war-steamer *Wateree*, which was swept a quarter of a mile inland, and lost but one man.

Some of the officers of the Wateree have reported the following facts:—

At 32 minutes past five o'clock, that is, 17 minutes from the cessation of the initiary shock, which lasted ten minutes, the first wave was experienced. These waves for a short period followed each other with great rapidity and regularity. The experience of those on the Wateree was peculiar. The water retired from the shore and then, unlike the regular pulsation or roll of the sea, rose from beneath, placing the ship, as it were, poised on the apex of a cone-like hill. This wave fell as suddenly as it rose, the steamer meantime shaking like a leaf in the wind; and then commenced a series of tidal rollers, first moving in grand masses toward the shore, and next retreating until those on the ship could see the ground of the roadstead almost from their anchorage to the shore. The vessel was swung and thrown hither and thither like a cork, and finally, on the ninth movement of the waters—the earth trembling without cessation, while the sky overhead was exceedingly clear and not a breath of wind stirred—was driven from her moorings and carried, losing one anchor and chain and taking the others with her, over the shore line and across the railroad, the track of which was destroyed, some distance inland, and finally left on an elevation of twelve feet on an otherwise level plain immediately north of the city, where she now lies apparently but little damaged, and, if she were worth it, in such a position that she can be moved back to the sea. The Wateree, being flat-bottomed, met with little obstruction, while the storeship Fredonia, being deep-keeled, was dashed against the rocks, and on the morning following the disaster, there was not a plank of her left that was whole. There were shocks of greater or less violence at Arica up to Aug. 30.

The destruction at Arica was complete. All public and private buildings, even the fort and the trees were swept away. Of the inhabitants some 200 perished.

At Callao the damage caused by the shocks was comparatively slight; that by the subsequent fire and inundation was very great.

The Port of Chala, about half-way between Callao and Iquique, suffered great damage, the havoc continuing for about forty-five minutes. At the moment the steamship *Santiago* was about to anchor, after a shock which was felt very sensibly on board, the sea receded, parting the chain of the vessel, and of the company's hulk, at anchor in the roadstead, and then returned at a height of about fifty feet, covering the rocks about the anchorage and in the harbor, and sweeping up into the town for the distance of over 1,000 feet. The Custom-house, Steamship Agency, Mole, and everything within range was swept away by three successive seas preceded and followed by as many as twelve shocks of earthquake, each lasting from three seconds to two minutes in duration.

The town of Tambo is entirely washed away, and upward of 500 persons have perished. The towns of Tiabaga Vitor, Molliendo and Mejia, and all the villages within 150 miles are totally

destroyed. In the latter place all the materials for the building of the Arequipa railroad, which were deposited there, were washed away. Mejillones is completely destroyed.

At Tacna it is said as many as sixty-four distinct shocks of earthquake were felt, and they continued up to the last date (16th). The towns of Sama and Lecomba are nearly destroyed. The earth opened in many places and vomited forth hot water. The valley of Lluta is completely ruined.

Owing to the elevation of the port, the damage done to Islay by the sea was not very great, though the earthquake wave rose to the height of sixty feet. The French ship *Canton*, although left high and dry, succeeded in floating off with the return sea. The mole is nearly destroyed. In the town every stone or cement wall is either demolished entirely or badly shaken. Among other freaks of the earthquake an entire new quebrada has opened at Guerreros, with a running spring at the bottom.

At the Chinca Islands the shocks were so strong as to throw every one to the ground. For a while after the subsidence of the earthquake the sea remained perfectly quiet, but about 9:30 o'clock at night commenced retiring, and when about seventy yards distant raised itself in an immense wave, which rushing forward threw itself with irresistible weight against the mole. The solid structure was instantly torn away. The inhabitants gave themselves up for lost, supposing the whole island was about to be submerged. The ships were dashed about like cockle-shells, and suffered great damage from striking against each other. All the launches and small vessels are totally destroyed, the wharves and the mole are so injured that immense sums will have to be expended on them before they can be of service.

In Ecuador repeated shocks were felt between the 13th and the 16th, the most destructive occurring at the latter date. At Guayaquil the first shock lasted forty or fifty seconds, the direction being from east to west, and the movement regular and slow. The exact date is not stated.

At Quito the severest shock, according to a Government circular, occurred a little after one o'clock A. M., of the 16th. It was prolonged and caused much damage to the city, with considerable loss of life. The greatest disturbance was in the province of Imbabura. Ibarra, its capital, San Pablo, Atuntaqui, Imantad, Otovala, and many other places are entirely in ruins. The shock happened at midnight, and was so sudden and violent that there was no time for any one to escape. In Ibarra, Otovala and Cotacachi almost the entire population perished. Where Cotacachi was is now a lake.

At Talcahuano, in Chili, no shocks had been felt on the 14th, but, the night preceding, an extraordinary wave from the sea had swept in upon the town, causing immense damage. At 10 o'clock at night the sea had gone back over 270 yards. A little before 11 o'clock it rose with a swell some 10 or 12 feet above its former level, and dashed upon the beach with an awful roar.

From 12 at night until 2 in the morning the sea was in great agitation, retreating and rushing forward by turns, and at last subsiding within its ancient bounds.

In Tome the town was likewise inundated.

In Constitucion the vessels anchored in the port were swept up the river, some of them being left aground and others sustaining considerable damage. The city itself was but slightly injured.

Earthquake Wave at the Sandwich Islands.—The oceanic disturbance caused by this earthquake was not confined to the South American coast, but extended across the Pacific, even to Japan. It was observed at the Sandwich Islands on the 14th, and for several succeeding days, and at Yokohama, Japan, on the 15th.

At Hilo, Hawaii, the phenomenon was first noticed at midnight of the 13th. A correspondent of the Honolulu Commercial Advertiser, writing on the 15th, states, that from that hour there had been a constant rise and fall of the ocean up to date, the fall being from 6 to 8 feet on the average, and occurring once in an hour through the day. The bridge at Waiakea had been lifted bodily from its position, and carried up the Waiakea as far as the fish-pond walls. This was done by the rise of 11 o'clock A. M. of the 14th. Another correspondent at Hilo states that the influx and reflux of the sea, as observed by his informants, had been taking place since the hour of 2 o'clock A. M. of the 14th, rising and receding every few minutes; from four to six feet being the general rise higher than usual tide. This continued throughout the day and night, and up to 4 P. M., the date of writing, on the 15th. A principal feature of the phenomenon noticed was its long continuance and regularity, varying little from five minutes in rising or receding, when receding the whole distance, sometimes falling but about one half the distance that it fell at other times.

From Kawaihae Mr. Conway writes, under date of Aug. 15th, that he was awakened between 3 and 4 o'clock on the morning of the 14th, by a peculiar rumbling noise, apparently as of stones rolled along the beach; and on going out, he saw the rocks on the beach, for several hundred yards, entirely bare. After a few minutes the water suddenly rushed in again with the rapidity of a six knot stream, and reached full thirty inches higher than the usual highest tides. After flowing and ebbing slightly for some ten minutes, with considerable agitation, it again receded to from two to three feet below the usual tide-marks; and so it continued to the time of writing, at longer or shorter intervals.

At Kealakekua, the extreme rise and fall was reported to have been about 10 or 12 feet.

From the Island of Molokai, Captain Fountain writes, under date of the 16th, that at 10 o'clock A. M. on the 14th, he noticed that the tide was four feet higher than usual, and that it rose and fell twelve times during the next four hours. The next day it continued the same, but longer between the time of rising and falling. On the 16th, it was continuing, but with the intervals still longer.

At Kahului, on the windward side of Maui, the phenomenon was first observed at early daybreak on the 14th, and continued during the day, leaving the reef and some rocks in the harbor quite bare. It was judged that the extreme rise and fall was nearly twelve feet. It was highest about 7 and 11 o'clock A. M. At places on the lee side of Maui, the rise and fall appears to have been not so great as at Kahului.

At Honolulu, the tide was first observed rising higher than usual about 9 o'clock P. M. of the 13th. At midnight the sea was receding, with a noise as of persons wailing, caused by the water rushing over the reef. At 7 o'clock the sea began to flow out rapidly, until 15 minutes past, when it checked and rapidly returned. The extreme fall, from the highest point, was three feet and ten inches. At 20 minutes past 8 A. M., the water again receded, and continued falling for 15 minutes, when it turned and rose 28 inches in eight minutes. Since that hour it continued rising and falling rapidly every 20 minutes, until about 25 minutes of 3 P. M., when it reached the highest point, five feet and four inches above the lowest mark.

At Waimea, Kauai, the tide rose and fell some six feet between the highest and lowest points observed, between 10 and 11 o'clock on the forenoon of the 14th. No measurements were taken.

It appears, from these reports, that at the Sandwich Islands the tidal oscillations were nearly uniform, throughout the group—that the tide rose highest and fell lowest on the windward or eastern shores of Maui and Hawaii—that it commenced nearly simultaneously at midnight, or a little before midnight, at the various points —that the greatest variations occurred at or about 7 and 11 o'clock A. M. on the 14th—that the oscillations continued from forty-eight to sixty hours from the commencement—and that at all the places where observed, the sea rose and fell *gradually*, though in some places more rapidly than at others, varying from four to twelve inches per minute.

The earthquakes of the same date in South America were obviously the cause of the phenomena observed at the Sandwich Islands and in Japan, the earthquake wave having occupied but a few hours in crossing the entire Pacific.

Earthquakes and earthquake waves in Australia and New Zealand.—On the morning of August 17 (Aug. 16 as compared with time in the Sandwich Islands) earthquake shocks were felt at several points in New Zealand, two occurring at Napier at $9^h\ 55^m$; Castle Point, $9^h\ 56^m$; Lyttleton and Nelson, $9^h\ 57^m$.

In eastern Australia there were unusual waves and tidal disturbance. At Sydney it was high water at 5^h on the 15th of August, and it was ebbing fast, when at 8^h it suddenly turned and ran with great force up the harbor, snapping the warps of one of the ferries, and creating much confusion. At one point the water rose two feet in five minutes. At Newcastle the ship Alexander was swept from her moorings; the water rose $2\frac{1}{2}$ feet in 15 minutes. Similar disturbances were experienced in Tasmania, Queens-

land and New Zealand. It is stated also that at the same time two slight shocks of earthquake were felt at Wellington, N. S. W., and at some other places; but whether on the same day precisely is not quite clear.

2. *Earthquake in California, Oct.* 21.—On the 21st of October, at 7h. 50m. in the morning, an earthquake occurred, doing considerable damage to houses, in San Francisco and Oakland. At the corner of Market and First streets, San Francisco, the ground opened several inches wide, for a distance of 40 or 50 feet. Another shock was felt in the city at 7 P. M.

The earthquake was also severe in the interior. Shocks were felt at Sacramento and Stockton; at Redwood City, where the court house is a wreck; at Marysville, slight; at Grass Valley, severe; at Sonora, light, but continuing nearly all day.

Other shocks are reported as having occurred at San Francisco on October 23d, 25th and 27th.

3. *List of Papers read at the session of the National Academy of Sciences in August, 1868, at Northampton.*

1. On the Tides and Tidal Currents of Hell Gate; Henry Mitchell, Assistant Coast Survey. Read by Prof. Peirce.

2. On the Rainfall of the United States; Chas. A. Schott, Assistant Coast Survey, from data collected by the Smithsonian Institution; paper presented by Prof. Henry.

3. Remarks on Mr. Airy's reduction of Kirchhoff's scale; Wolcott Gibbs.

4. On the origin of bitumens, together with experiments upon the formation of Asphaltum; J. F. Peckham.

5. On the Topography and topographical work west of the 103d meridian; J. D. Whitney.

6. On an invariable meter; A. C. Twining.

7. On the Tides and Tidal currents in an estuary or a canal between two tidal stations; Benjamin Peirce.

8. On deep sea dredgings in the Gulf Stream; L. F. Pourtales.

9. On subdivisions of Cretaceous and Marine Tertiary formations in California; W. M. Gabb.

10. On the constitution of Uric Acid and its derivatives; Wolcott Gibbs.

11. On new methods in Analytical Chemistry; Wolcott Gibbs.

12. On the fossil human skull of Calaveras county, California; J. D. Whitney.

13. On the distribution of the Forest Vegetation west of the Rocky Mts.; W. H. Brewer.

14. On the reported occurrence of human bones at Antelope station, Union Pacific Railroad; O. C. Marsh.

15. On the motions of a freely suspended pendulum; J. G. Barnard.

16. Tides and tidal currents in a harbor; Benjamin Peirce.

17. On alphabetic systems as tests of race; W. D. Whitney.

18. On the estimation of Carbonic acid; S. W. Johnson.

19. On Nitrification; S. W. Johnson.

20. On a new Borate from Mine Hill, Sussex Co., New Jersey; G. J. Brush.

21. Some points in the Surface Geology of the region west of the Rocky Mts.; J. D. Whitney.

22. On the transportation of the materials of the Carboniferous Conglomerate; J. S. Newberry.

23. On the deposits of Sulphate of Strontia on Strontian Island, Lake Erie; J. S. Newberry.

24. A new and general method of developing the real roots of an equation, essentially extracted from my algebra, page 512; Theodore Strong.

25. Remarks on the pendulum and gyroscope as exhibiting the rotation of the earth; J. G. Barnard.

26. On some interesting points in the structural geology of the Nile Valley; J. P. Lesley.

4. *On a Meteorite which exploded over Kansas, June* 6, 1868; by Prof. B. F. MUDGE, (communicated for this Journal.)—At twenty minutes before noon, June 6th, a most brilliant meteorite was seen in our western sky. It exhibited a pink flame, shining with so vivid a light, that had it occurred in the night it would have obscured the full moon. It descended at an angle of 75° with the horizon, leaving a streak or sharply defined line of its track, which continued nearly a minute. When first seen by me, it had an elevation of 55°, though others saw it still higher. The diameter of the nucleus was about 15′ or nearly half the diameter of the moon. It descended with great velocity, (in less time than one second) and when 12° above the horizon, bearing 10° N. of W., exploded, sending two streams of fire toward the earth. The report of the explosion followed in about four minutes and a half, (owing to inadvertence the time was not exactly noted.) The detonation was double but following each other in quick succession, nearly simultaneous. Here it sounded as loud as a twelve-pounder a mile distant. Those west of us, who heard it, described it as more like sharp thunder. A farmer in the Republican valley, fifty miles from this place, supposed it was the steam boiler of a mill, and hurried to the spot to learn the damage done. On exploding, it produced a light blue cloud one and a half degrees long and two-thirds as wide, which floated in sight seventeen minutes without much diminution in size, when a passing cirro-cumulus cloud obscured it. The report was heard over an area 120 miles in diameter and the meteorite was seen much farther, viz., at Topeka, Marysville, Fort Harker, Fort Zarah and intermediate points. Its flight was apparently from south to north, though its motion was so rapid and nearly perpendicular, that it was difficult to determine.

The following are its elements, very nearly:

Height when first seen,	81 miles.
" " it exploded,	12·5 "
Length of the cloud caused by the explosion,	1·44 "
Breadth "	·96 "
Size of the neucleus or head,	1,890 feet.
Distance from this place when it exploded, about	58 miles.

It must have exploded over the country about midway between the Republican and Solomon rivers, which has few inhabitants. An aerolite must have fallen and I have spent some time in endeavoring to find it, but thus far without success.

State Agricultural College, Manhattan, Kansas.

5. *Corrigenda for Article* XIV *on Vision.*—In the article on Vision by S. ROWLEY in our September number (p. 153), notice of two omissions in the statement of the proposition was forwarded by the author, but reached us too late for insertion. The following are the corrections to be made:

In 8th line from bottom of page 155 (counting the lines of the note), between the words *behind* and *the*, insert the words, *the center of*.

In 4th line from top of page 156, between the words *plane* and *perpendicular*, insert the words, *passing through the middle of the interval between the eyes and the point of intersection of the optic axes.*

6. *British Association.*—The next meeting of the British Association will be held at Exeter, under the presidency of Prof. G. S. Stokes, Sec. R. S.

V. MISCELLANEOUS BIBLIOGRAPHY.

1. *Report of* J. Ross BROWN *on the Mineral Resources of the States and Territories west of the Rocky Mountains.* Washington: Government Printing Office, 1868. 8vo, pp. 674.—We find in Mr. Brown's Report a large mass of important and interesting information which it is desirable should be accessible in a compact form for the use of all who wish a resumé of the existing state of development as well as of the general nature and extent of the vast mineral regions of the U. S. *west* of the Rocky Mountains.

As Mr. Brown is neither a mineralogist, geologist nor miner, we can fairly look in this document only for such information as an industrious collector of facts and an experienced traveler may amass upon almost any subject to which he brings zeal and intelligence. We can readily overlook numerous slips in matters technical and scientific, in view of the substantial contribution Mr. Brown has made to our literature upon this subject. The want of good maps (or maps of any kind), of plans and sections in Mr. Brown's Report, we regret the less, now that we know that these are being supplied in a manner which can hardly fail to be satisfactory by the labors of the party under the guidance of those experienced topographical and geological explorers, Messrs. King and Gardner, whose survey of the 40th parallel covers a zone of country reaching from the Sierra Nevada to the eastern slopes of the Rocky Mountains, within which fall the most important mining districts of the great interior basin of the continent. It may be two or three years yet before we get the full returns of this large and well organized party, but the volume on the mining regions of Nevada, Montana, Idaho, Utah, and Colorado, which embraces the labors of the mining engineer, Mr. James D. Hague, charged with this

special department, will, we understand, be in readiness for presentation, this coming session, to Congress.

About one half of Mr. Brown's Report is occupied with a detailed notice of the gold region of the State of California. The silver regions of Nevada occupy the next important place; after which, Arizona, Utah, Montana, Idaho, Washington Territory, Oregon and Alaska are discussed; followed by general observations on the "Pacific Slope;" general considerations on the precious metals; foreign States and Territories, and an Appendix, containing various official and leading documents relative to mining.

On the whole, we rise from an examination of Mr. Brown's Report with a feeling that he deserves praise for good sense and intelligence, which he has brought to his difficult task. This good sense he has shown in nothing more than in the use he has made of the labors of others who have preceded him in the same fields, labors generally, but not always, properly acknowledged. The chapters on the Sutro Tunnel, the general considerations on the precious metals, and that on Lower California and on Mexico, are those which possess perhaps the highest permanent value of any portion of the Report. Under the same covers with Mr. Brown's Report, we find a

2. *Report of* JAMES W. TAYLOR *on the "Mineral Resources of the United States east of the Rocky Mountains."* pp. 71.—A more utterly incompetent and wretched discussion of a great theme never disgraced a Governmental Blue-Book. Of its 71 pages, barely 28 are from the pen of its reputed author; and if the whole of this hotch-potch of "Canadian Mines," "Nova Scotia," Metallurgical Treatment, Taxation, Transportation, and Foreign Railways, had been omitted, the value of the document would not have suffered. The Appendix, which forms more than one half of the Report, reproduces an old Essay on Artesian Wells, by D. D. Owen, Dr. Hayden's late paper on the Western lignites, from this Journal, a fair essay on the mineral resources of Montana, by W. S. Keys, M. E., and a long letter from Mr. Gold-Commissioner Hamilton of Halifax on the gold and coal mines of Nova Scotia. What the United States may have to do with the Gold Regions of Canada, and the Gold and Coal regions of Nova Scotia, does not appear from the context, although it is evident that their annexation to Mr. Taylor's Report fills an important void.

We cannot refrain from expressing our surprise and amazement that our Government should intrust a commission so important as that of preparing a Report on the Mineral Resources of the States and Territories East of the Rocky Mountains to such unworthy hands. The country abounds with men who have devoted their lives to the study of our geological and mineralogical resources, and whose published works bear ample testimony to their ability to serve their country and advance science. In passing by these men and selecting the author of the document before us, the Government places the country in a false position before the whole world, and fails utterly in the only object it can have in the production of such official Reports.

3. *A treatise on the Concentration of all kinds of Ores, including the Chlorinatian Process for Gold bearing Sulphurets, Arseniurets and Gold and Silver ores generally;* by GUIDO KUSTEL. 259 pp. 8vo, with 120 diagrams on 7 plates. (San Francisco: office of Mining and Scientific Press. New York: Western & Co., office of American Journal of Mining.)—Mr. Kustel has already done great service for practical metallurgy by the publication of his book on the "*Nevada and California processes of Gold and Silver extraction*," and the present work is one of much importance to both miners and metallurgists. It is, we believe, the only work of the kind in the English language, and besides original material, gives us the latest results attained abroad, and especially much of the valuable matter contained in the recent elaborate work of von Rittinger. It is very systematically arranged—an introductory chapter treats of the general principles of ore dressing, the separation from the gangue in and outside the mine, ragging, spalling, cobbing, etc.; the different varieties of cleansing apparatus, and the various kinds of rotary sizers. The second division of the subject entitled "*reduction*," treats of the different breakers, crushers, and pans, with a proper consideration of the theoretical points involved in the construction of these machines. The third and fourth sections of the book are devoted to "*concentration*" and "*special concentration*," under which the principles involved in concentration are discussed, with descriptions of the various jigs, setz-machine, setz-rad, buddles, sleeping and percussion tables; in short, the principal machines and methods employed in ore concentration. The fifth division is devoted to the *chlorination process*, and is the most complete presentation of the subject that has yet been published. As before stated, the work contains much that till now was inaccessible to the English reader, and we believe that a careful study of the principles contained in it will be of great service to all interested in this department of practical science. G. J. B.

4. *The American Annual Cyclopedia and Register of Important events of the year* 1868. Vol. vii. 8vo, pp. 799. New York, 1868. (D. Appleton & Co.)—Like its predecessors, this portly annual volume is devoted to bringing down to date all the more important events of the year 1867, political, civil, military, and social affairs, public documents, biography, statistics, commerce, finance, literature, science, agriculture and mechanical industry. The ample space of these volumes admits a degree of fullness in the discussion of important subjects which gives to the prominent articles the character of separate treatises. The articles on scientific subjects are of course not very numerous. Those of most prominence are chemistry, electricity, geographical explorations and discoveries, French Exposition, magnesium, medicine, metals, meteors, sulphur produce of Italy, and test of iron by magnetism. The volume closes by a useful analytical table of contents, in addition to the usual index of subjects.

5. *The Wine Maker's Manual;* by CHARLES REEMELIN, author of the "Vine Dresser's Manual." 123 pp. 12mo. Cincinnati, 1868.

(Robert Clarke & Co.)—This little manual is especially intended as a guide to small farmers and others who wish to make wine in small quantities, whether from grapes or other fruits. The author is evidently a person well acquainted with the practice of his art, and treats his subject in a plain and conscientious manner. The English of the book would have been improved by a little friendly review, and the same may be said of its chemistry. But the notions sought to be conveyed are good and will meet the demand from the class to which it is especially addressed. The mechanical production of the book is extremely tasteful. The author, like all other writers of books on the grape and wines east of the Mississippi, seems to forget that California is one of the States of the American Union. The only paragraph in the book in which California is mentioned, speaks of Coutro Krota County, meaning Contra Costa County, a blunder which any gazetteer would have corrected. But the climate, vine and soil of California are so entirely unlike anything in the Eastern United States, and especially in their peculiar adaptation to the production of the grape and its wine that we can hardly include them in a book intended for those who cultivate the vine of the eastern United States.

6. *Chambers's Encyclopedia: a Dictionary of Universal Knowledge for the people.* (Illustrated.) Vols. viii–x. Philadelphia: Lippincott & Co.; Edinburgh: W. & R. Chambers. Large 8vo. 1867–1868.—The tenth volume completes this excellent work, the progress of which we have noticed from time to time in former volumes of this Journal. Its character for fullness, accuracy and general interest is well maintained to the end. Over 27,000 articles, comprising nearly every department of human knowledge, are in its alphabetical list. Its natural history articles, and those on the various physical and chemical sciences, are numerous and well illustrated by good wood-cuts in the text. Particular attention seems to have been given to those subjects which have an interest for Americans. Its biographical articles are numerous and embrace the living as well as the dead.

In an appendix which fills two-thirds of the final volume, many articles are added to keep pace with the rapid progress of science in its various departments. The article on chemistry brings forward in a manner on the whole pretty satisfactorily, the modern chemical philosophy, recognizing fully its importance, and rapid strides toward supremacy. Sir Benjamin Brodie's Calculus of Chemistry is not forgotten. It is a singular proof of the slowness with which the Anglo-Saxon mind adopts new ideas, that in 1868 it is still deemed essential in a leading exponent of the existing state of knowledge, to give in connection with the article chemistry an elaborate exposition of the metrical system of weights and measures, now for a generation in almost exclusive use among all scientists out of England. As is unavoidable, we find no mention of many subjects which might very naturally be looked for, but on the whole, he will be a captious reader who does not find in Cham-

bers and its supplement more than he can inwardly digest. In the appendix many of the scientific and mechanical novelties of the last few years are well treated of, such for example, as the Gas-Engine; Electro-magnetic Engine of Wilde; Blowing machines including Root's of the U. S.; Armorer Plates; Artificial Limbs; Breech-loading arms (deficient in no mention of important American forms); Cattle Plague; Chemistry; Coal Supply; Cohesion Figures; Compressed AirEngine; Dipsomania; Floating Docks; Meteors; National Education (an elaborate and important paper); Nitro-glycerine; Refrigerating Machines; [Here again the American researches of Twining reproduced in the English Ettier refrig- and the air rarefactoire of Gerrie described in a series of articles in this Journal more than 20 years ago, are not mentioned]; Sanitary Science; Thermo Dynamics, are examples of subjects discussed. We do not know if it is the purpose of the publishers to maintain the status of the excellent Encyclopedia by the addition of an annual volume as has been done by the Appletons for the American Encyclopedia,

7. *Mitchell's Manual of Practical Assaying*, 3d edition. Edited by WILLIAM CROOKES, F.R.S. London. 8vo, pp. 697, and lvii of tables. London, 1868 (Longmans, Green & Co).—Mitchell's Assaying is a book by far too generally known to require any extended notice; but the appearance of the third edition of Mr. Crookes's reminds us that it is fourteen years since the second edition (1854) was published, and in that time many important discoveries and improvements have been made in the various methods of chemical and metallurgical analysis, which are now well brought up by Mr. Crookes. The volumetric and colorimetric methods of assay have especially given precision and rapidity of execution to many cases of analysis before difficult and uncertain. These, as well as the blowpipe assay by the latest methods of Prof. Kerl, are found fully set forth in this edition, which thus becomes the best manual for practice in our language. The use of the old English weights and measures is still adhered to, as indeed is necessitated by the law requiring assay reports to be made in ounces, pennyweights and grains, all the gold and silver tables being rendered in the same terms. In the volumetric assays, however, the rational methods of the metrical system are employed.

8. *The Workshop: A monthly Journal devoted to the progress of the useful arts.* E. Steiger (17 William st., N. Y).—We have before announced Mr. Steiger's reproduction of this excellent German Art Journal, edited by Professors Baumer and Schnor. With the completion of the first six months the Workshop appears in an enlarged form, evincing a determination to keep well up with the growing taste for genuine art culture. It is a work which commends itself to all whose tastes or vocations lead them in this direction. The articles are original, critical and suggestive; the illustrations varied, numerous and beautifully executed, and are accompanied by working drawings which every artist will appreciate as bringing to a practical test the examples given. To the German more than to any other people do we owe the recent rapid

progress of correct ideas and sound principles in art; but until now the English reading artists have had very limited means of information in this direction. This want the Workshop does much to supply, and we cheerfully commend it to general attention.

9. *Thesaurus Siluricus: The Flora and Fauna of the Silurian Period, with Addenda* (from recent acquisitions); by JOHN J. BIGSBY, M.D., F.G.S., formerly British Secretary Canadian Boundary Commission, etc., etc. 214 pp. 4to. London, 1868. (J. Van VOORST.)—This work is a condensed and comprehensive review of the facts in Silurian paleontology. It is the result of a vast amount of labor on the part of one who has examined for himself the Silurian rocks of a portion of North America, and studied carefully the investigations of others all over the world. The subjects are discussed with ability, evidently after careful study, and with the aid of some of the best paleontologists of England. The principal topics considered are zoological considerations, geographical distribution, locality, time of first appearance of species, duration and extinction, migration and recurrence. The tables include, the author states, 997 species, which is more than four times as many as were comprised in Bronn's admirable tables of 1856. To no geologists has the work greater interest than to those of North America.

10. *Exposé des Formations Quaternaires de la Suède;* par A. ERDMANN. 118 pp. 8vo, illustrated by 26 wood cuts, with an atlas in quarto of 14 plates.—Prof. Erdmann has here presented an abridgment "pour l'étranger" of his larger work on the Quaternary or Post-tertiary formations of Sweden. The facts are closely related to those of North America, and throw much light, therefore, on American geology. Prof. Erdmann divides the era into the Glacial and Post-glacial. The Glacial includes two epochs, that of glaciers, and that of submergence and submarine deposits. The Post-glacial is also divided into two epochs, 1, that of submarine deposits; 2, that of the more recent terrestrial and submarine beds. The several subdivisions are treated of with much interesting detail. The quarto atlas is one of great beauty, containing, besides sections, several maps illustrating the distribution of the deposits, the direction of scratches, etc.

11. *Prof. Safford's report on the Geology of Tennessee.*—Prof. Safford writes that he is engaged in the preparation of his report, and that he hopes to have it out in an abridged form in January.

12. *The American Entomologist.* Edited by BENJ. D. WALSH of Rock Island, Illinois, and C. V. RILEY of St. Louis, Missouri. Vol. I, No. 1, September, 1868. 20 pp. large 8vo.—This is the first number of a new Entomological Journal published at St. Louis. Its aim, as stated in the prospectus, is to promote the interests of Entomology, and espécially to disseminate practical information to farmers, gardeners, fruit growers and others. Its editors are fully capable of sustaining well the Journal, and this first number holds out excellent promise for the future. The price per year is but one dollar.

13. *How Crops Grow. A Treatise on the Chemical Composition, Structure and Life of the Plant, for all Students of Agriculture, with numerous illustrations and tables of analyses;* by SAMUEL W. JOHNSON, M.A., Professor of Analytical and Agricultural Chemistry in the Sheffield Scientific School of Yale College, &c. 394 pp. 12mo. New York, 1868. (Orange Judd & Co.)—Prof. Johnson is so completely master of his subject that anything coming from his pen carries with it the prestige of authority. This volume well sustains the author's established reputation. It is the result of much study and experience as an instructor, and is specially adapted to a large class of readers whether interested in pure or applied science. It is to be followed by two and perhaps three other volumes in the same line; the second of the series, to be entitled "How Crops Feed," is nearly ready for the printer; the third volume will be upon Cultivation, or the Improvement of the Soil and the Crop by Tillage and Manures. The closing volume of this important series will be devoted to Stock Feeding and Dairy Produce considered from the point of view of Chemical and Physiological Science. It is easy to see how valuable such a series must be to all who are interested in agriculture in its various departments, and to scientific readers they will furnish a reliable epitome of the sciences discussed.

14. *A Treatise on Optics; or Light and Sight theoretically and practically treated; with the application to fine art and industrial pursuits;* by E. NUGENT, C.E. With one hundred and three illustrations. 8vo, pp. xii, 235. New York, 1868. (D. Van Nostrand.)—Mr. Nugent has succeeded in condensing into this little book a large amount of valuable information. While he has not burdened its pages with abstruse formulas, he yet has been able very clearly to demonstrate the principles of refraction, reflexion, dispersion, polarization, etc. The opening chapter gives a succinct history of optical science; the next fourteen chapters are occupied with a discussion of theoretical optics; in the sixteenth a description is given of the more important optical instruments, as the camera—giving figures of the best lens combinations of Dallmeyer and others—the microscope with its appliances, the telescope, stereoscope, sextant, theodolite, engineer's transit, etc.; and in the seventeenth many important practical applications of optical principles are discussed; among them photo-zincography, photolithography, the influence of colored light on the germination and growth of seeds, and light-house illumination. The matter of the book is well digested, the illustrations are good, and the style in which it is issued is unexceptionable.

15. Part 2 of the *Butterflies of N. America*, with beautiful colored plates, by WM. H. EDWARDS, has just been published in Philadelphia.

NOTE.—*Illustrations of this volume.*—For the illustrations of the article on the Eozoon (p. 245) we are indebted to the liberality of Sir Wm. Logan; and for those of the article on the secular variations of the Earth's Orbit by J. L. Stockwell (p. 87), on the Amiens Gravel by Tylor (p. 302), and on Siredons by Prof. O. C. Marsh (p. 364), to the several authors.—EDS.

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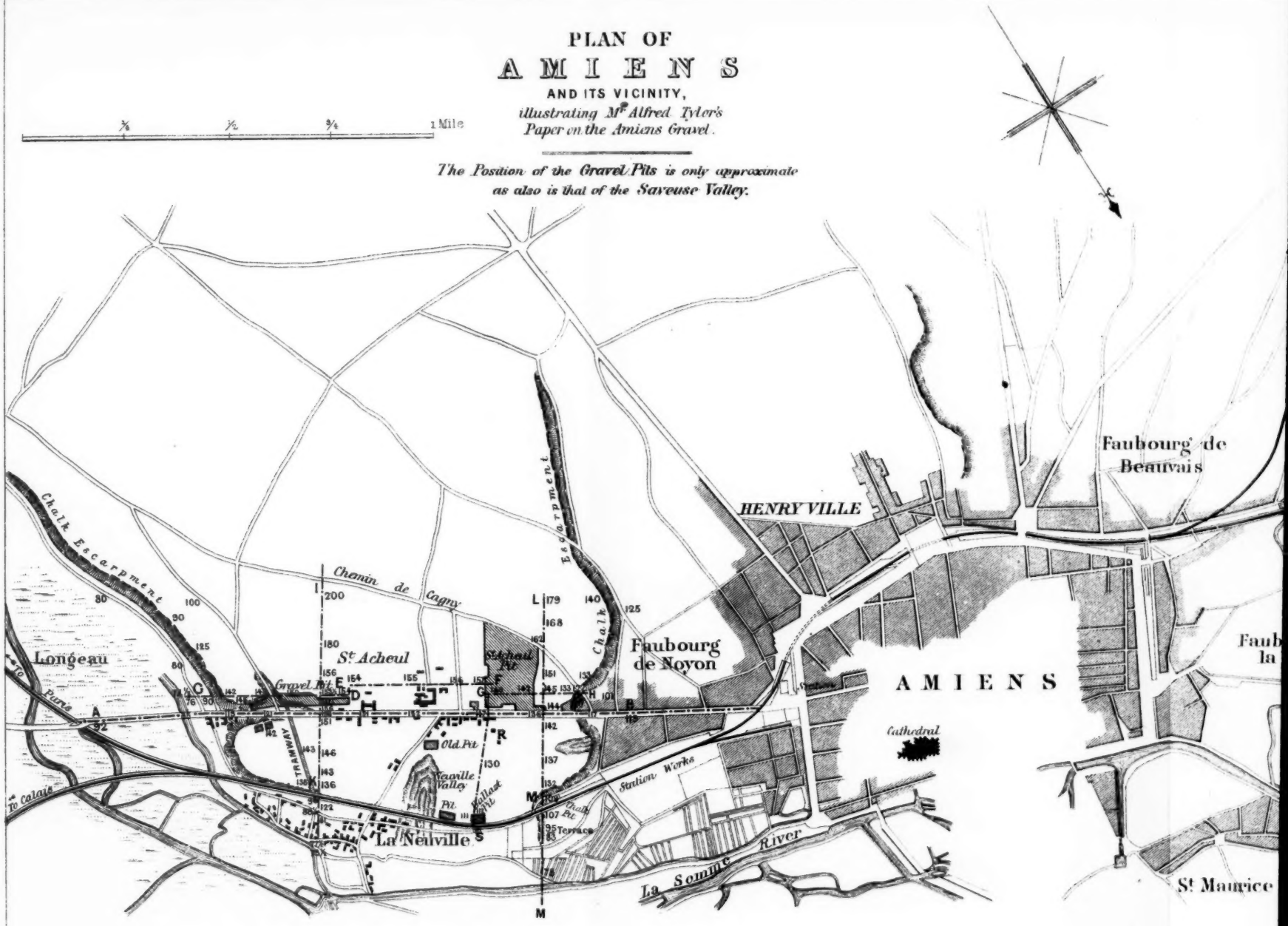
PLAN OF
AMIENS
AND ITS VICINITY,

illustrating Mr Alfred Tyler's Paper on the Amiens Gravel.

¼ ½ ¾ 1 Mile

The Position of the Gravel Pits is only approximate as also is that of the Saveuse Valley.



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LAN OF

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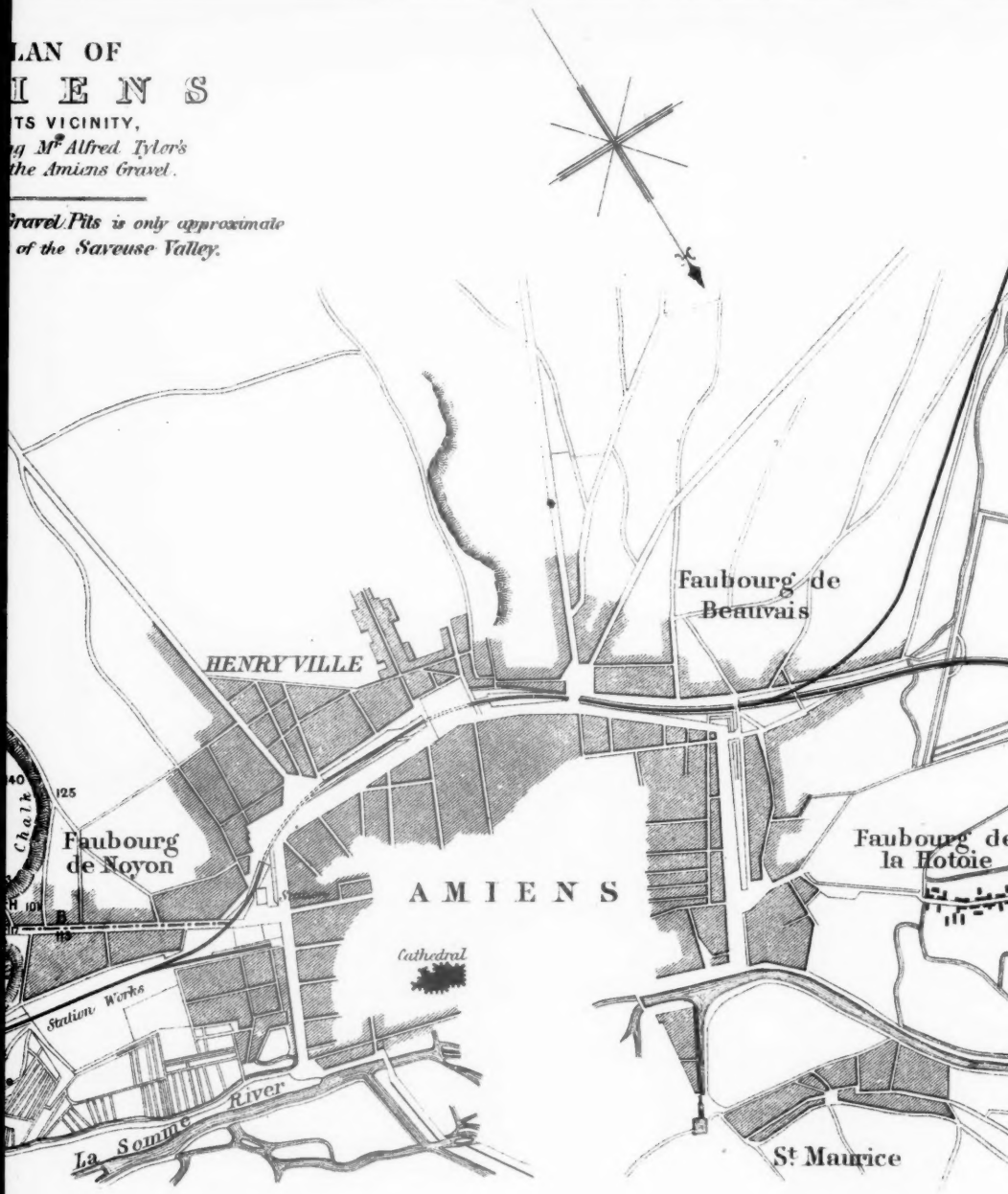
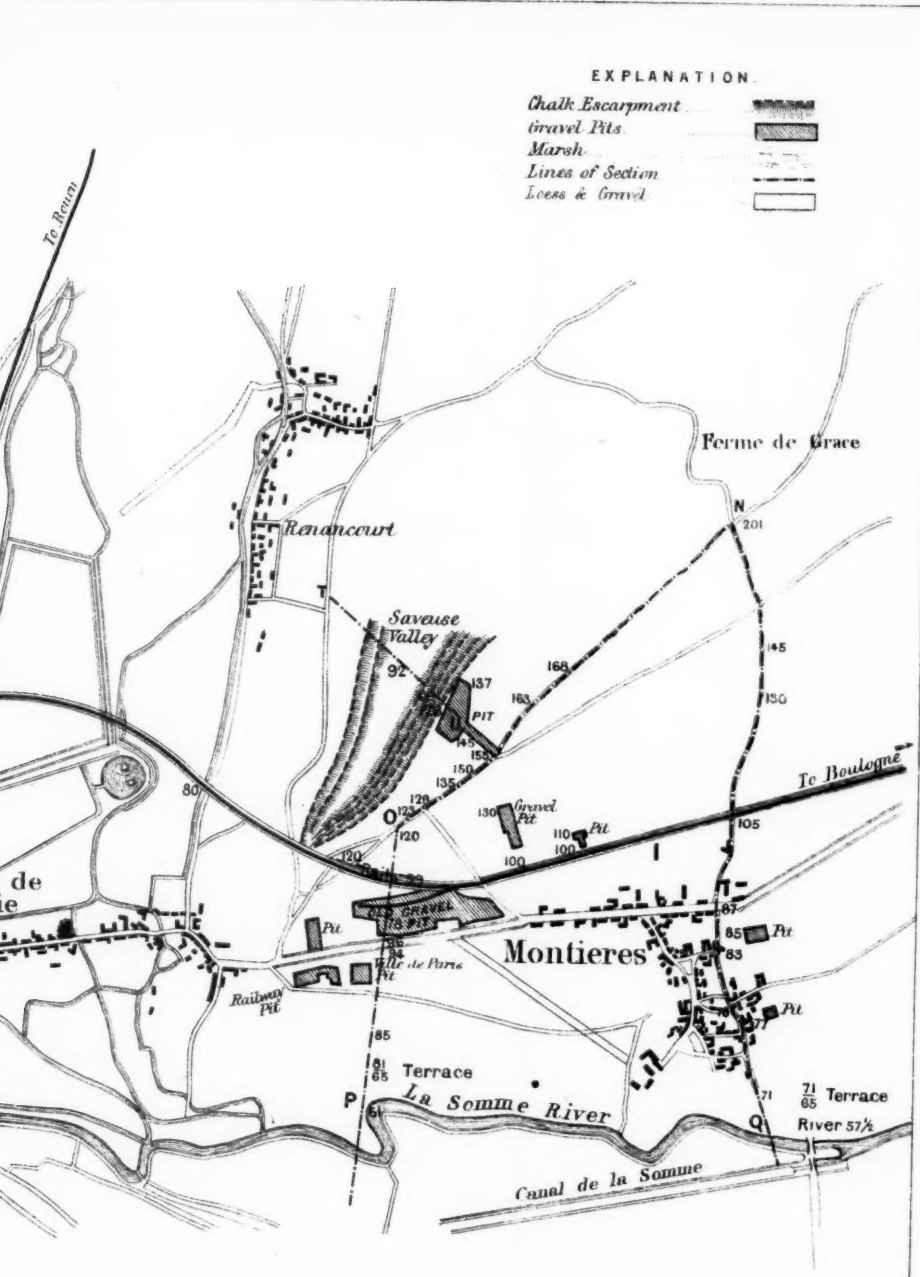
TS VICINITY,

g M^r Alfred Tylor's
the Amiens Gravel.

Gravel Pits is only approximate
of the Saveuse Valley.




EXPLANATION.
Chalk Escarpment
Gravel Pits
Marsh
Lines of Section
Loess & Gravel
To Reims
Ferme de Grace
Renancourt
Saveuse Valley
92
137
PIT
168
163
145
150
135
120
130
Gravel Pit
110
100
Pit
105
To Boulogne
80
Pit
Montieres
85
63
Railway Pit
Terrace
La Somme River
71
65
Terrace
River 57½
Canal de la Somme
N
201
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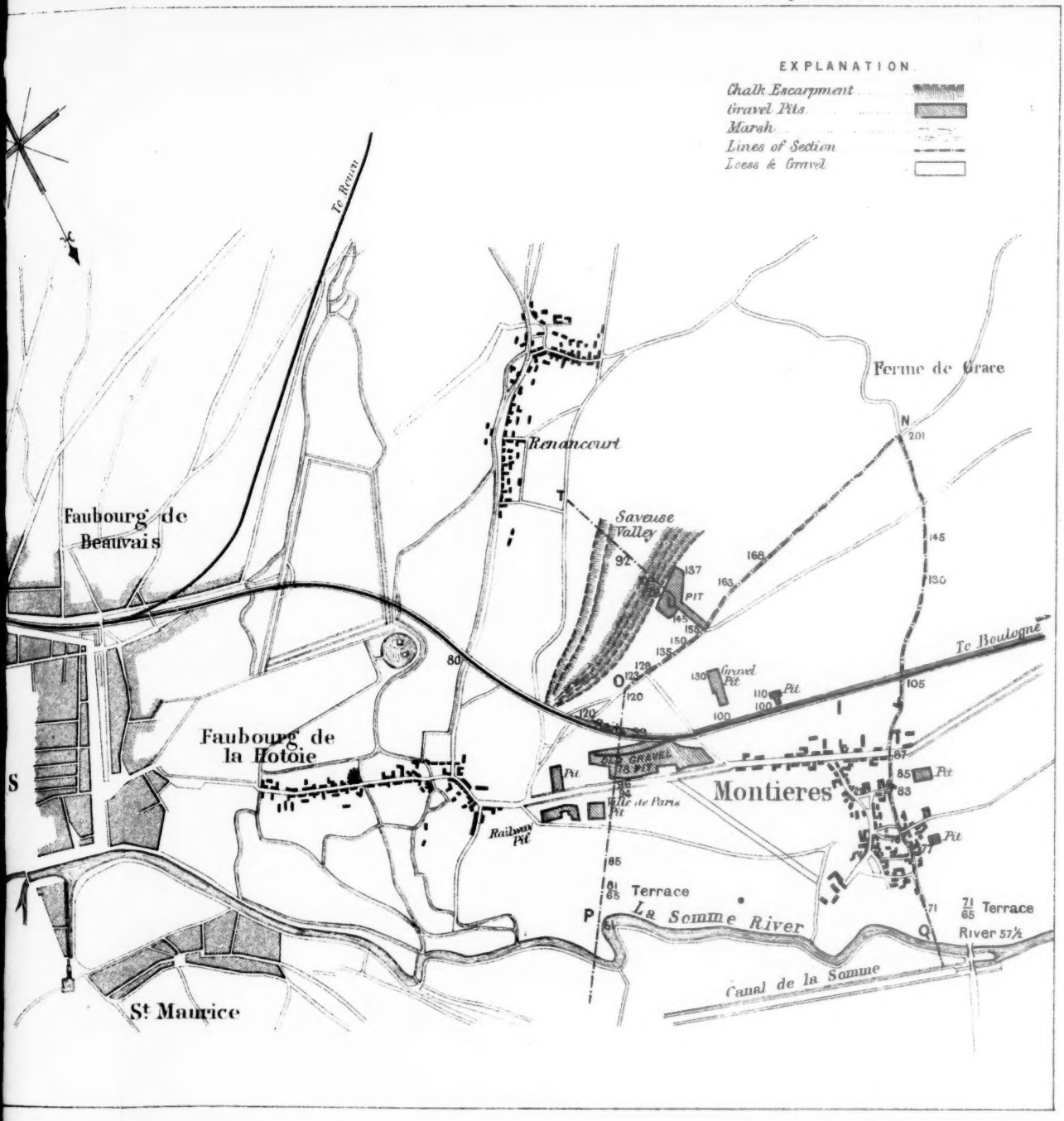

EXPLANATION.
Chalk Escarpment
Gravel Pits.
Marsh
Lines of Section
Loess & Gravel
To Rouen
To Boulogne
Ferme de Grace
Renancourt
Faubourg de Beauvais
Faubourg de la Hotoie
Saveuse Valley
Montieres
Railway
Pit
Terrace
La Somme River
River 57½
Canal de la Somme
St Maurice
Gravel Pit
Pit
PIT
Ville de Paris
71/65 Terrace

Fig. 1 *Section along the Tramway, from the Imperial Road east of St Acheul to the Railway.* R. S.

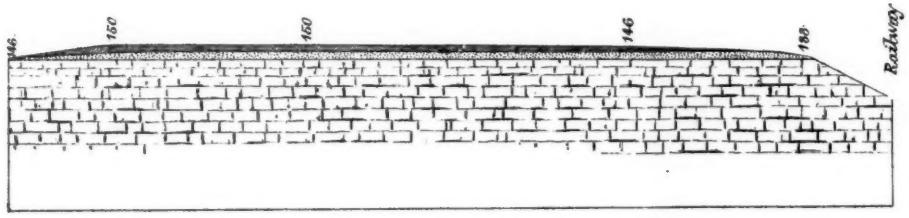


Fig. 2. *Section from the Imperial Road to la Neuville Ballast Pit, along the line.*

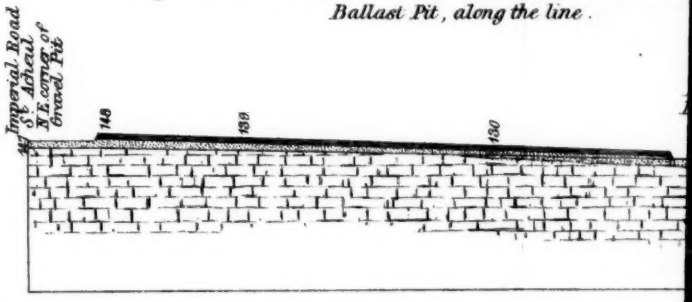


Fig. 6. *Section along the line.* I. K.

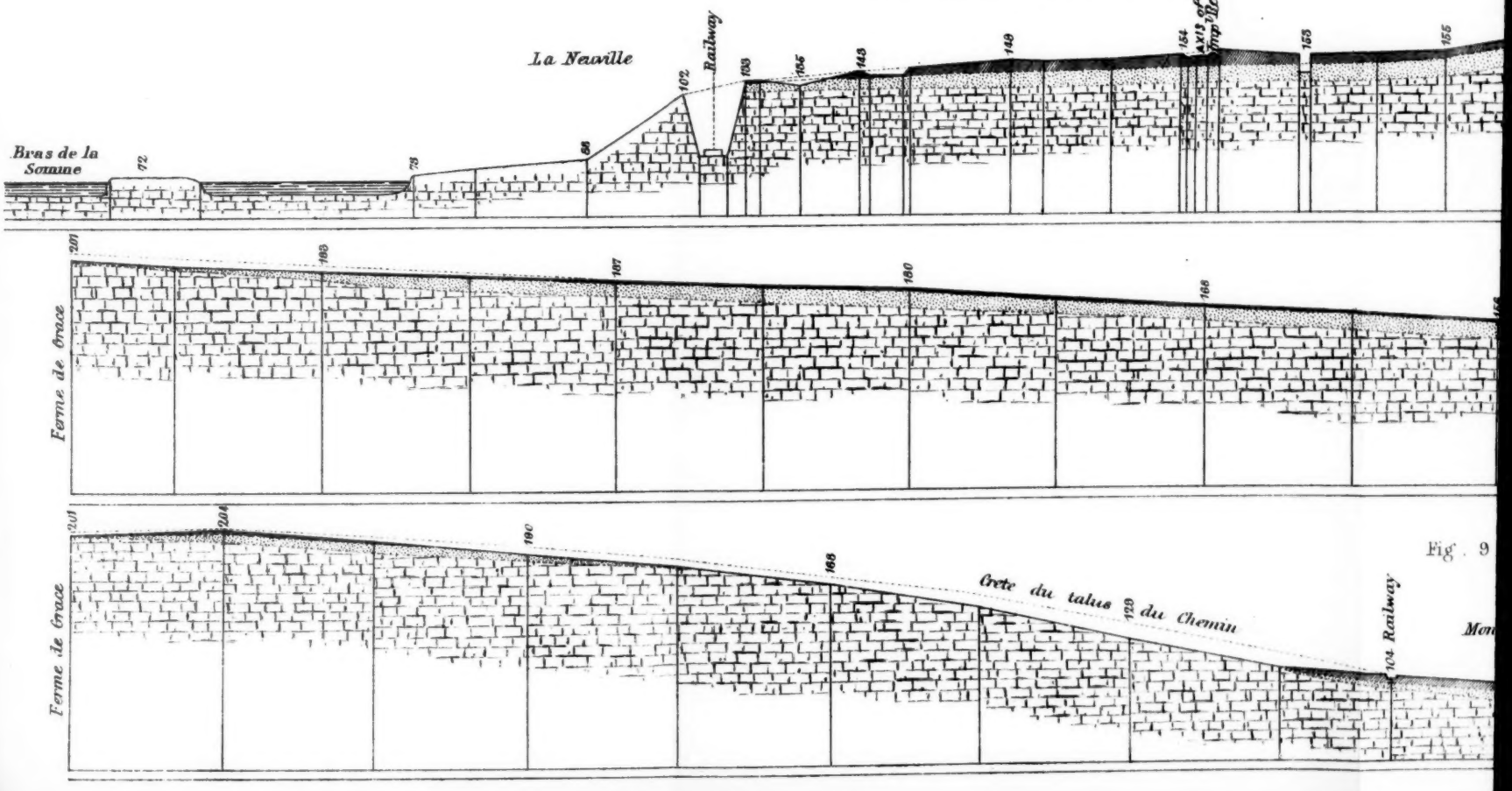


Fig. 9

Road east of
R. S.

Fig. 2. *Section from the Imperial Road*
Ballast Pit, along the

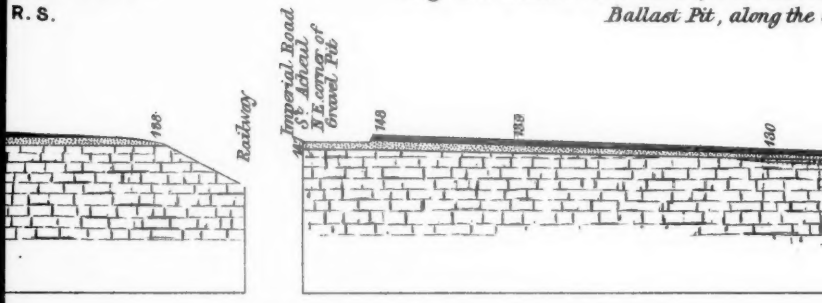
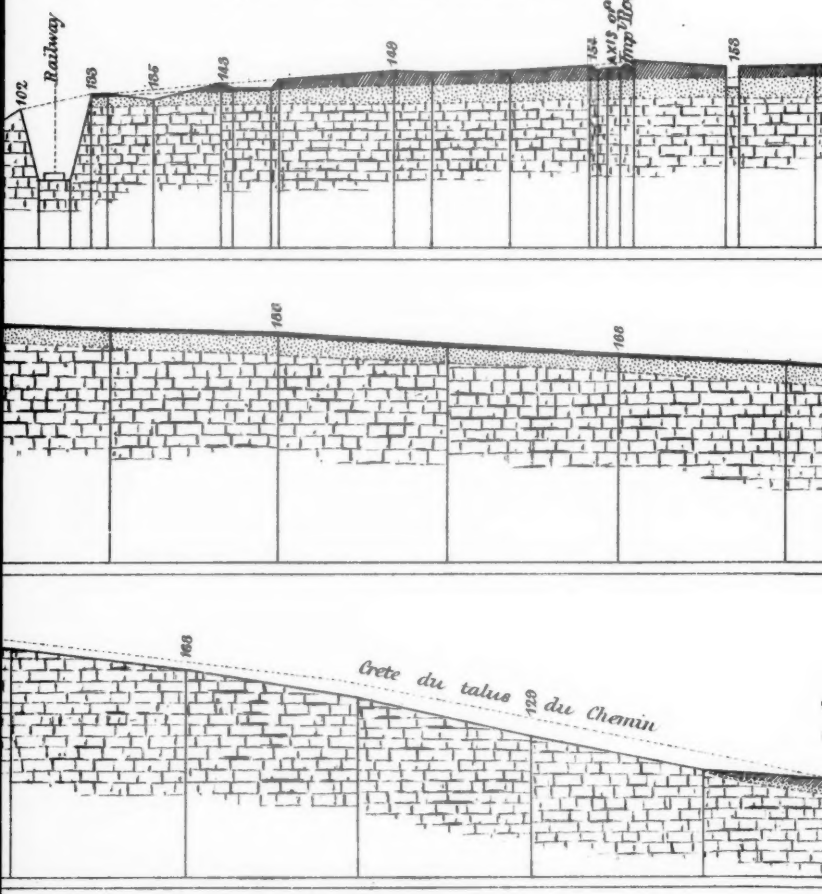


Fig. 6. *Section along the line.* I. K.



SECTIONS IN THE ENVIRONS OF AMIENS, PRINCIPALLY SURVEYED BY M. GUILLOM CHIEF ENGINEER OF THE CHEMIN DE FER DU NORD

To illustrate Mr Tylor's paper on the Gravel of Amiens.

erial Road to la Neuville
, along the line.

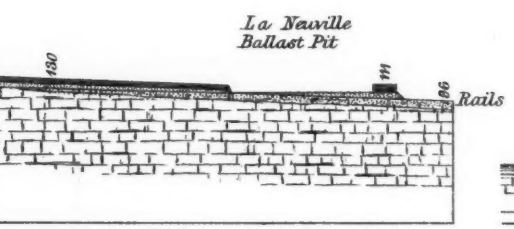
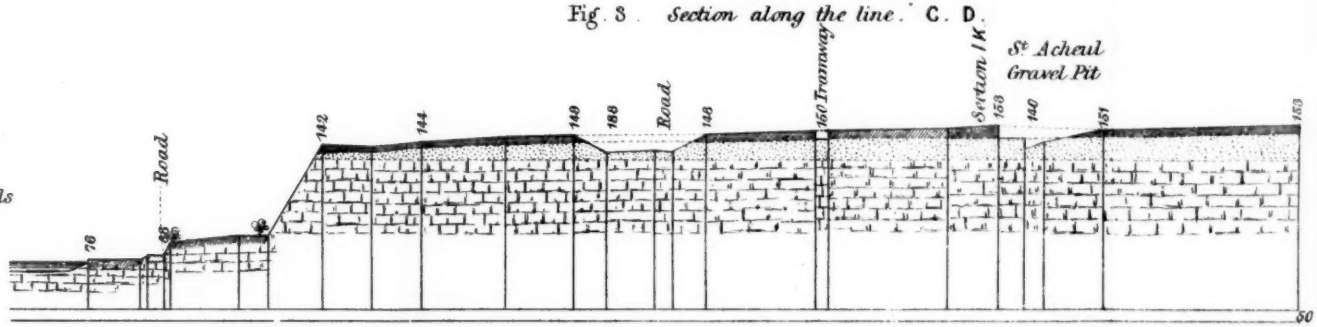


Fig. 8 *Section along the line.* C. D.



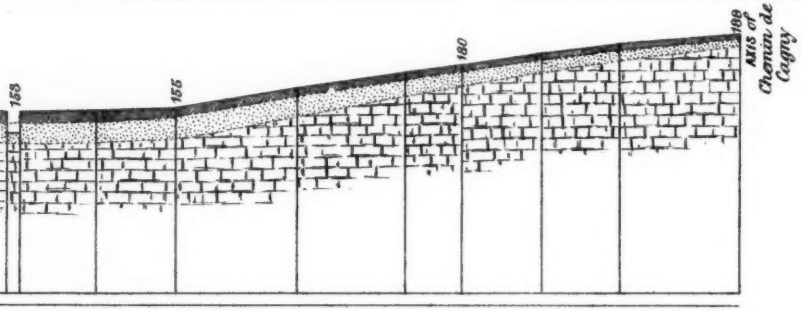


Fig. 7. *Section along th*

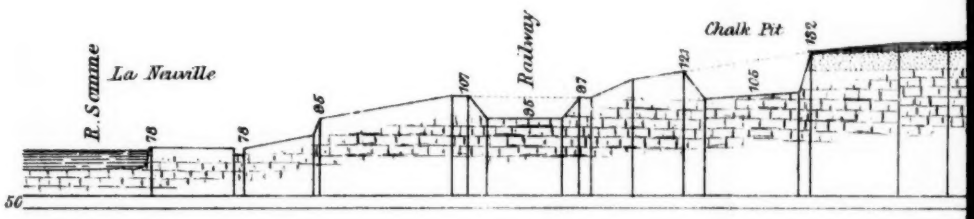


Fig. 8 *Section along line.* N O. P.

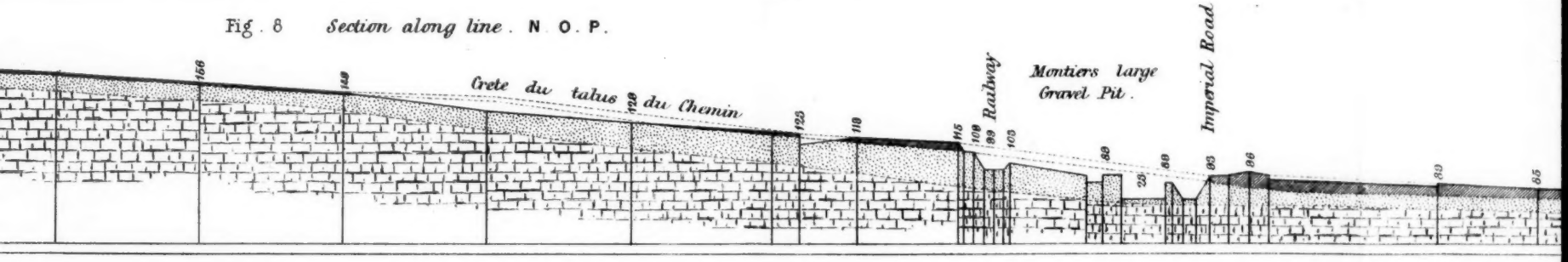
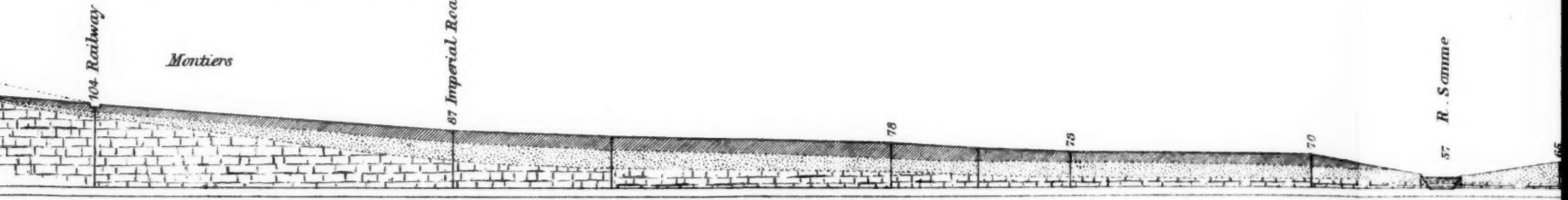


Fig. 9. *Section along the line* N. Q.



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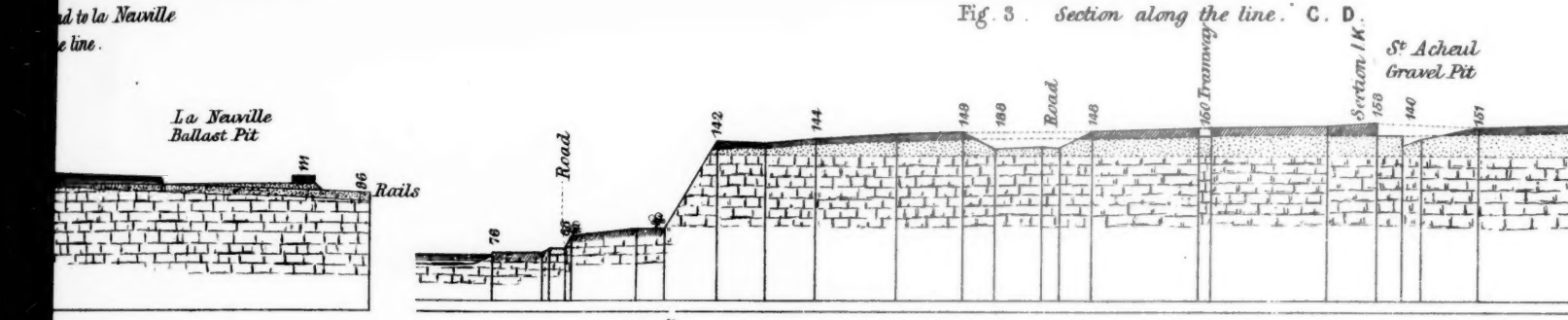


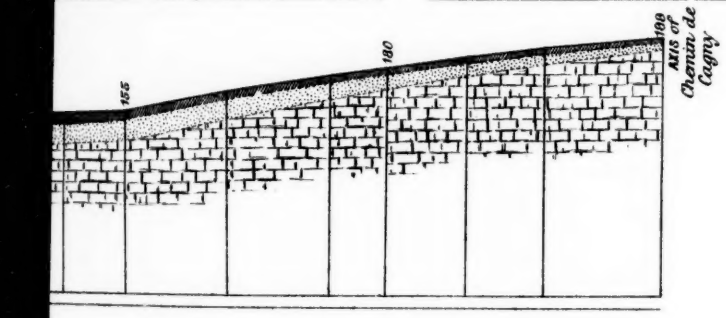
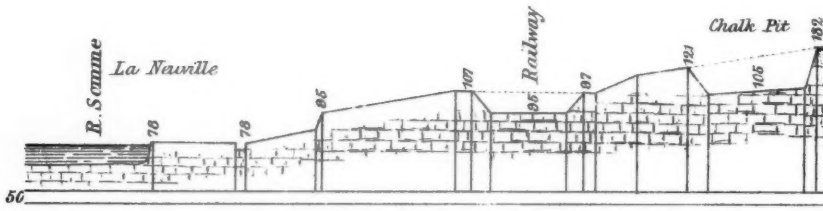


Fig. 8 Section along line. N O. P.



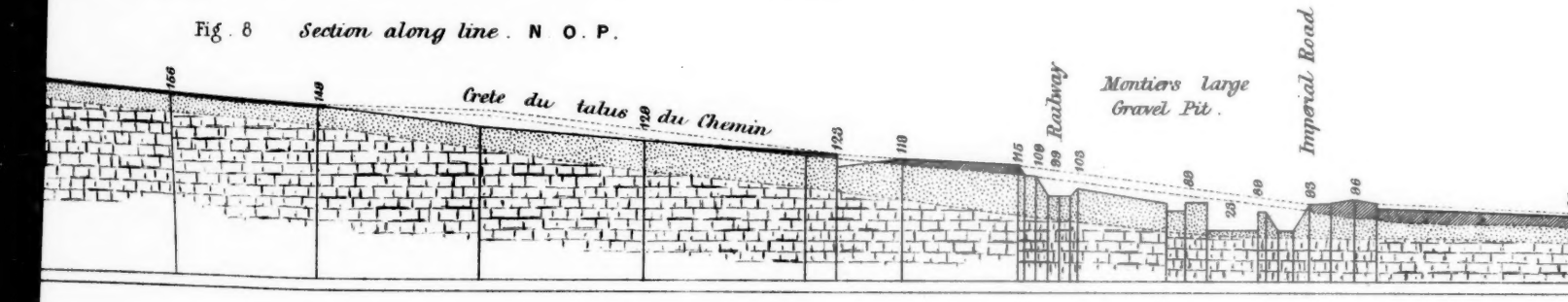


Fig. 9. Section along the line N. Q.

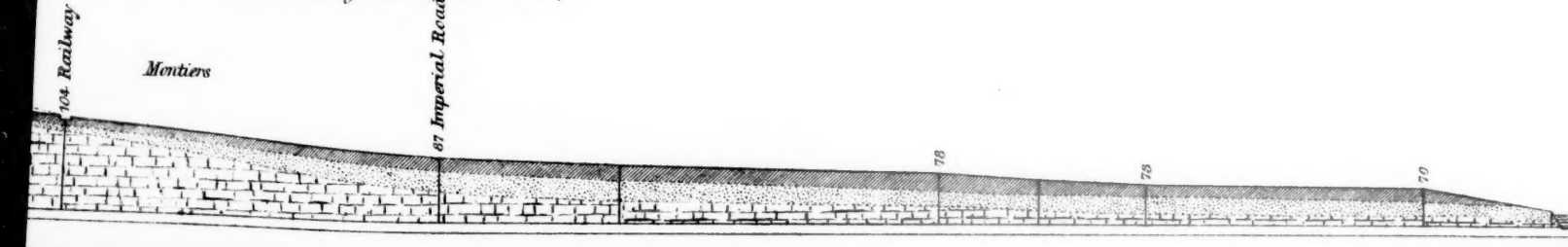


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Fig. 4. *Section along the line* E. F.

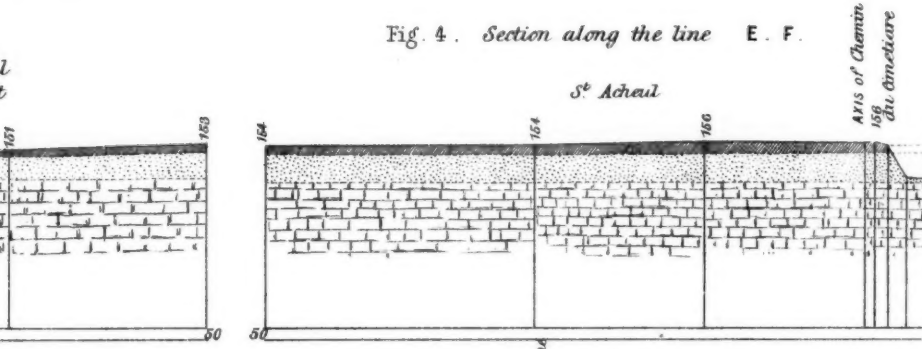
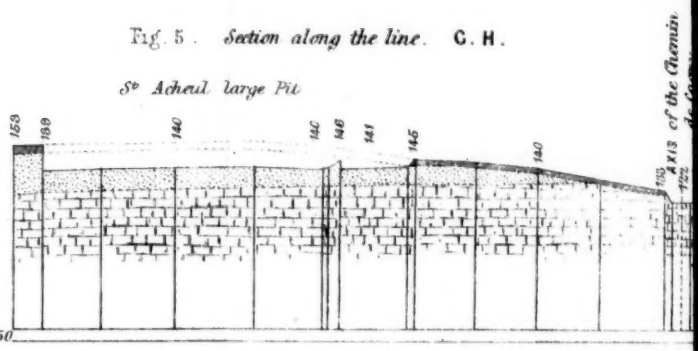
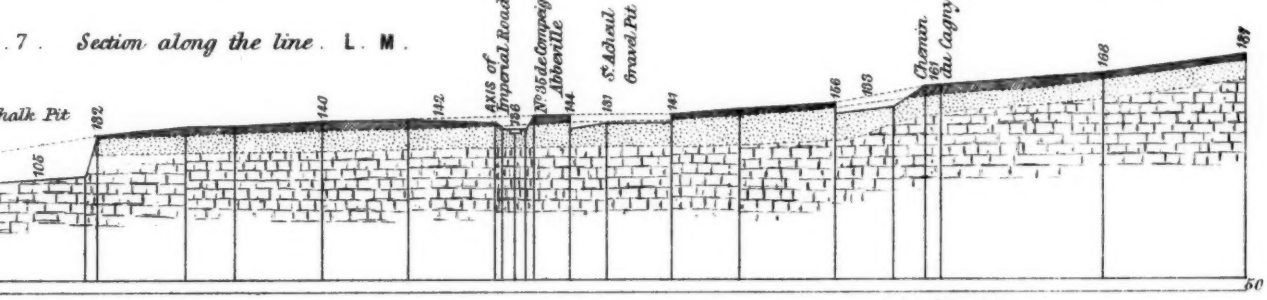


Fig. 5. *Section along the line.* C. H.



. 7. *Section along the line.* L. M.



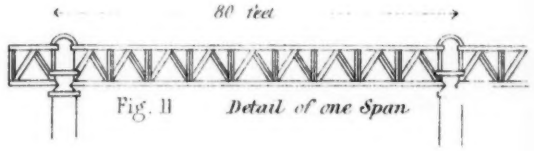
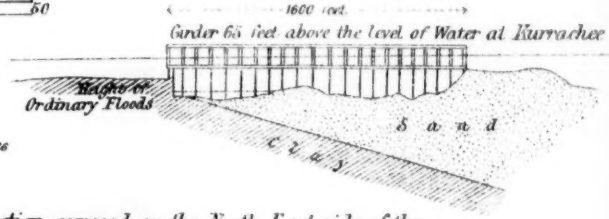
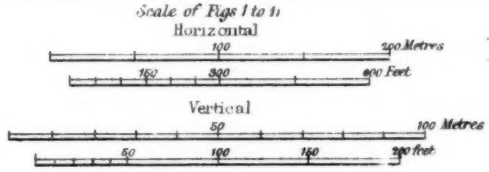


Fig. 11 *Detail of one Span*

Fig. 10. *Section of a Bridge 16 Miles east of Kurrachee on the Sinde Railway*





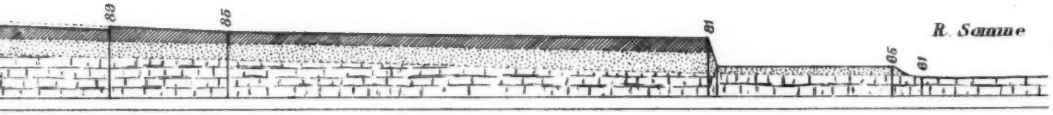


Fig. 12. *Section exposed on the North East side of the St Acheul Gravel Pit*

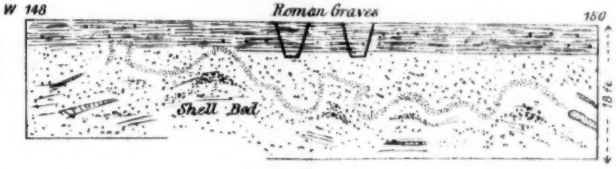
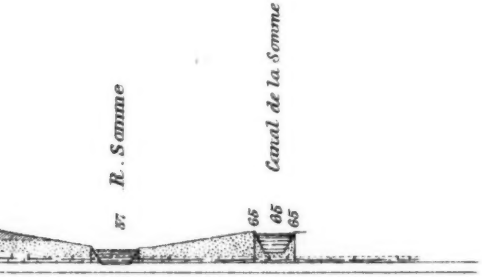
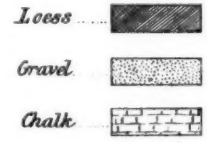


Fig. 13. *Section along the South bank of the Imperial Road between the Rue de Cagny and St Acheul, 100 yards long 11 feet high.*





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RVEYED BY M.GUILLOM CHIEF ENGINEER OF THE CHEMIN DE FER DU NORD.

lor's paper on the Gravel of Amiens.

Fig. 3. *Section along the line.* C. D.

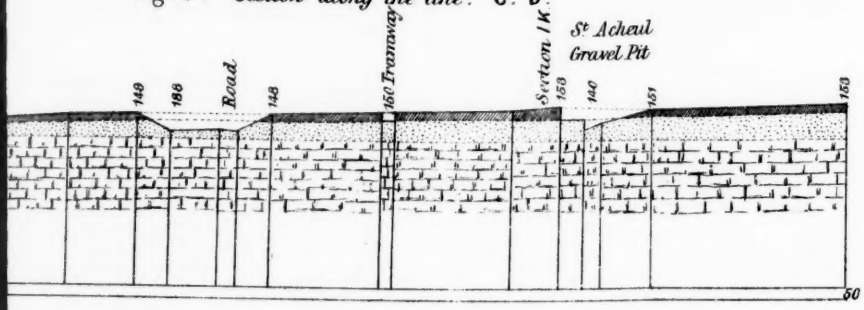


Fig. 4. *Section along the line* E.

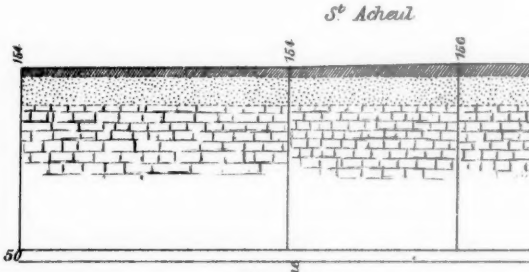
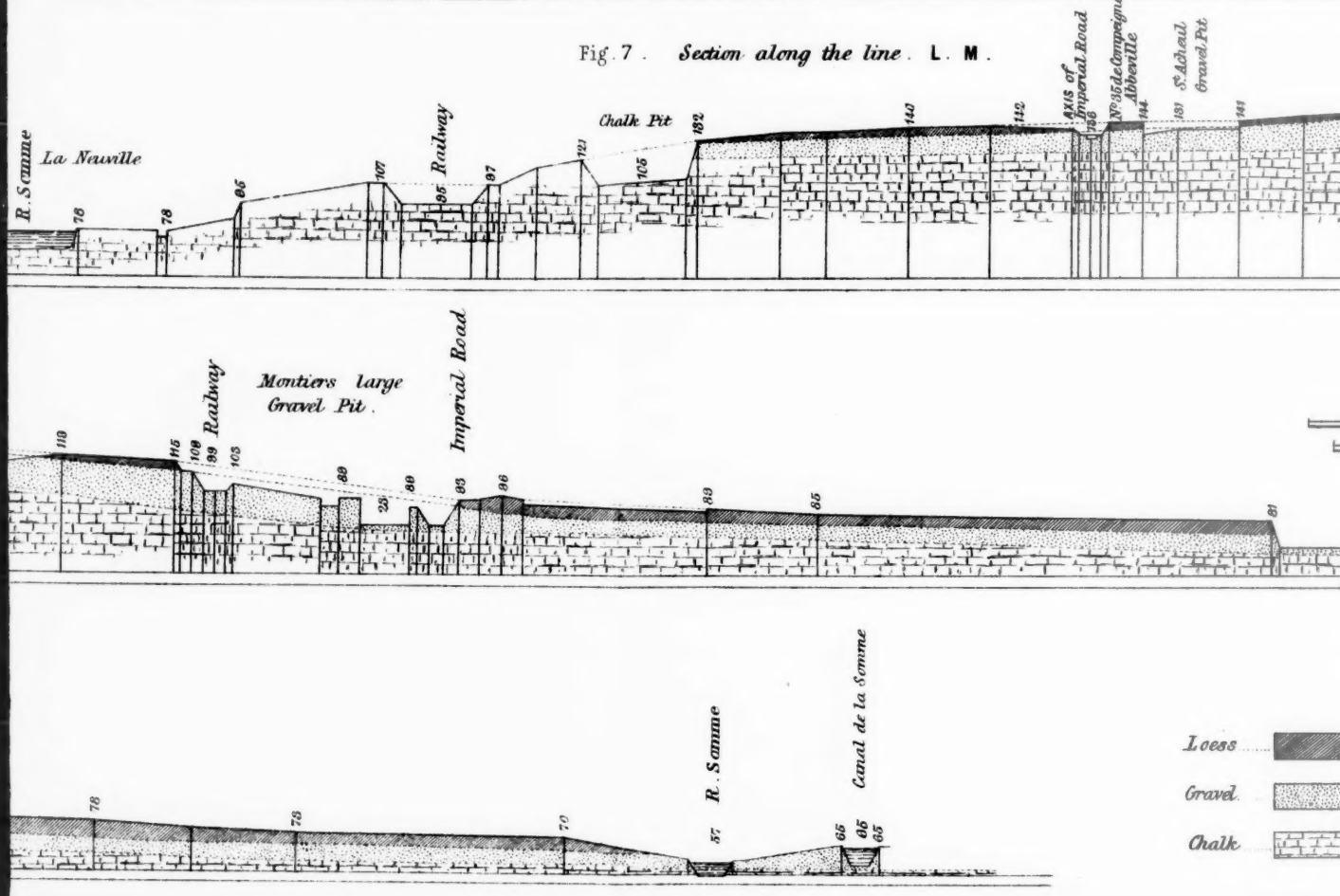
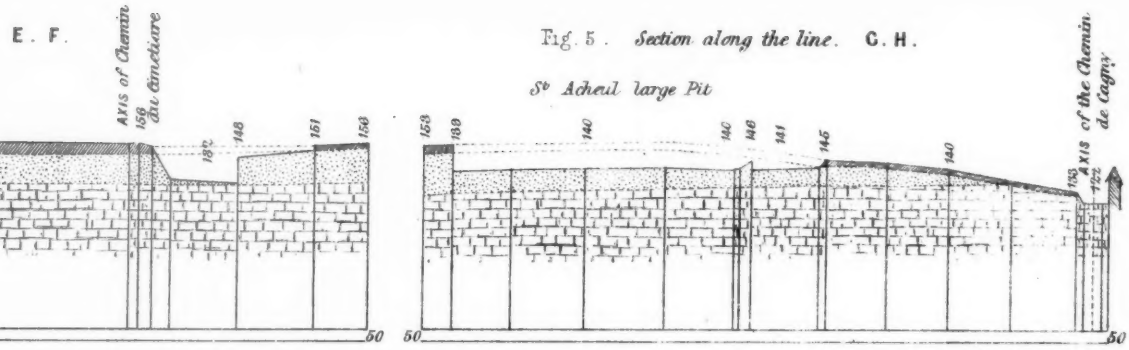
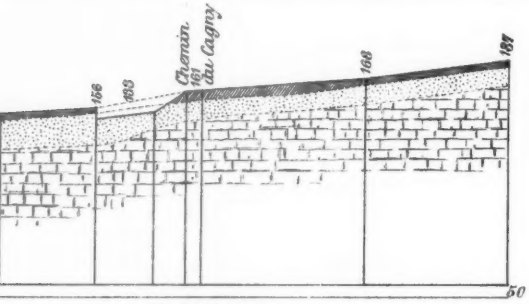


Fig. 7. *Section along the line.* L. M.







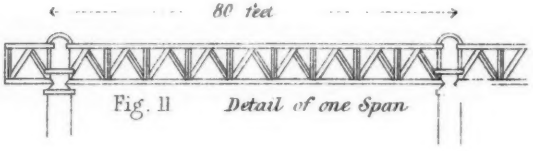


Fig. 10. Section of a Bridge 16 Miles east of Kurrachee on the Sinde Railway

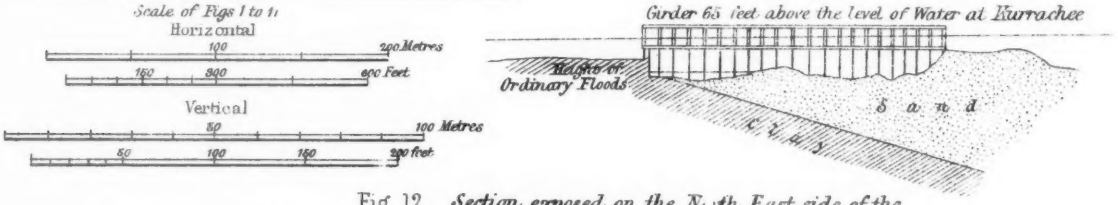


Fig. 12. Section exposed on the North East side of the St Acheul Gravel Pit

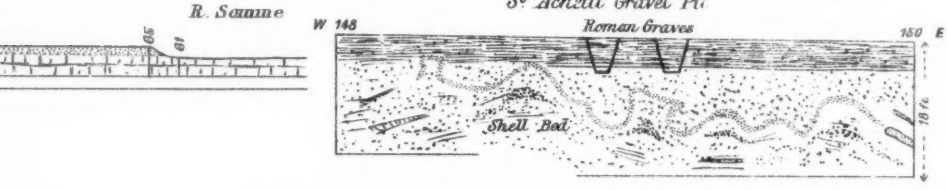
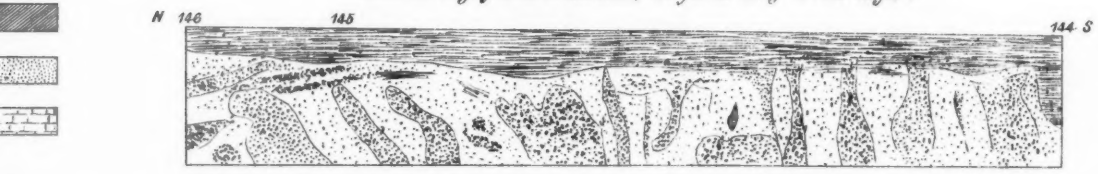


Fig. 13. Section along the South bank of the Imperial Road between the Rue de Cagny and St Acheul, 100 yards long 11 feet high.



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